North Coast Watershed Assessment Program

Gualala Watershed Synthesis Report

The mission of the North Coast Watershed Assessment Program is to conserve and improve California's north coast anadromous salmonid populations by conducting, in cooperation with public and private landowners, systematic multi-scale assessments of watershed conditions to determine factors affecting salmonid production and recommend measures for watershed improvements.

DRAFT

Appendices Table of Contents

Additions to the Appendices will include:

- KRIS discussion of its use as an encyclopedia and adaptive data warehouse
- Maps/GIS documentation
- PDF Map list
- Document Use/Adaption
- Web site and access

APPENDIX 1

NCWAP Program Introduction and Overview

The North Coast Watershed Assessment Program (NCWAP) was established in 2000 to provide a consistent scientific foundation for collaborative watershed restoration efforts and to better meet the State needs for protecting and restoring salmon. This effort was initiated by the California Resources Agency in response to requests by landowners, industry and environmental groups, watershed groups, a Science Review Panel on Forest Practices, and others for state leadership in assessing the health and conditions of north coast watersheds.

The program was developed as an interagency effort by the California Resources Agency and CalEPA, and includes the Departments of Fish and Game (DFG), Forestry and Fire Protection (CDF), Conservation's Division of Mines and Geology (DMG), and Water Resources (DWR), and the State Water Resources Control Board's North Coast Region (RWQCB). The Institute for Fisheries Resources is also a participant in this program. The geographic scope of the program corresponds to the North Coast Hydrologic Region (Figure 1). This includes about 6.5 million acres of private watershed lands over a total area of 12 million acres. The assessment is designed to cover all private watershed lands over a period of about seven years.

The need for comprehensive watershed information grew in importance with listings of salmonids as threatened species, the TMDL consent decree, and the proliferation of assistance grants for protecting and restoring watersheds.
Listings under the federal Endangered Species Act for areas within the NCWAP region (the North Coast Hydrologic Unit) began with coho salmon in 1966, followed by Chinook salmon in 1999 and steelhead in 2000. In 2001, coho was proposed for listing under the California Endangered Species Act in 2001. Concerns about the potential impacts of salmonid listings and TMDLs on the economy are particularly strong on the North Coast where natural-resource dependent industries predominate. Many of these activities, along with natural processes, can impact watershed conditions and fish habitat, including landslides, flooding, timber harvest, mining, ranching, agricultural uses and development. In order to recover California's salmonid fisheries, it is necessary to first assess and understand the linkages among management activities, dominant ecological processes and functions, and the factors really limiting populations and their habitat.

The North Coast Watershed Assessment Program integrates and augments existing watershed assessment programs within proven methodologies and manuals available from each department. The program also responds to recommendations of the Scientific Review Panel (SRP) which was created under the auspices of the State's Watershed Protection and Restoration Council, as required by the March 1998 Memorandum of Understanding (MOU) between the National Marine Fisheries Service (NMFS) and the California Resources Agency. The MOU required a comprehensive review of the California Forest Practice Rules (FPRs) with regard to their adequacy for the protection of salmonid species. In addition, the promise of significant new state and federal salmon restoration dollars highlighted the need for watershed assessments to ensure those dollars are well spent.

PROGRAM GOALS

The goals of the program are to:

1. Provide baseline data for evaluating the effectiveness of various resource protection programs over time;
2. Guide watershed restoration programs, e.g., targeting grant dollars to those projects that most efficiently and effectively recover salmonid populations, and assisting local watershed groups, counties, etc., to develop successful projects;
3. Guide cooperative interagency, nonprofit and private sector approaches to "protect the best" through stewardship, easement and other incentive programs;
4. Help landowners and agencies implement laws that require specific assessments such as the State Forest Practice Act, Clean Water Act and State Lake and Streambed Alteration Act.

The program is designed to answer or begin to assess watershed conditions as they relate to a set of critical questions about suitability for salmon habitat, tailoring the assessment process to those that are most relevant to each watershed. The questions include the following:

- What are the general relationships between land uses history (development, timber harvest, agriculture, roads, dams diversions, and mining) affected nd the current vegetation and level of disturbance in North Coast watersheds? How can these kinds of disturbance be meaningfully quantified?
- What is the spatial and temporal distribution of sediment sources from landsliding, bank, sheet and rill erosion, and other erosion mechanisms, and what is the relative importance of each source in North Coast watersheds?
- What are the effects of stream, spring and groundwater uses on water quality and quantity?
- What role does large woody debris have within the watershed n forming fish habitat and determining channel class and storing sediment?
- What are the current salmonid habitat conditions in the watershed and estuary (flow, water temperature/shade, sediment, nutrients, instream habitat, LWD and its recruitment); how do these compare to desired conditions (life history requirements of salmon, Basin Plan water quality objectives)?
- What are the sizes, distributions and relative healthiness of populations of salmonids within watersheds?
- Do current populations and diversity of aquatic communities (especially salmonid fishes, macroinvertebrates, and algae) reflect existing watershed and water quality conditions?

ASSESSMENT PROCESS

Since watersheds are hierarchical in structure and function, we will gather and analyze data at multiple scales to answer these questions, ranging from the stream reach to the subwatershed and finally whole watershed or basin. While the NCWAP is primarily an assessment with existing data, some new data collection will occur as resources allow to provide a current picture os some components of a watershed. With respect to temporal scale, NCWAP will discuss processes that have affected these watersheds in pre- European time, but will focus on the current state of a given watershed and its relationship to the land management activities of European-Americans over the past 150 years. Within that period, the program will try to look at changes in the watersheds in the framework of critical dates and periods defined by major natural perturbations, and periods wherein a new resource extraction tool, policy or program entered the scene.

NCWAP will produce and make available to the public of consistent set of products for each basin we assess. They include the following:

- Databases of information that we have used and collected for our analysis. We will also provide a data catalogue which identifies all the information we considered, and evaluates its usefulness for our assessment process, and a bibliography of other references cited in the assessment report.
- Geology and landslide maps and maps of instream sediment and transport zones developed by the Division of Mines and Geology.
- An Ecosystem Management Decision Support (EMDS) model that describes how watershed conditions interact at the stream reach and watershed scale to affect suitability to fish.
- GIS-based models and analyses such as timber harvest frequency, road-based erosion model runs,
- Limited Cumulative Watershed Effects (CWE) (define NCWAP spatial and temporal limitations)
- An interdisciplinary analysis of the results of fieldwork, historical analysis, EMDS and other analytical products about the suitability of stream reaches and the watershed for salmonids.
- An interagency description of historic and current conditions by subwatersheds as they relate to suitability for salmonid fisheries. This will address vegetation cover and change, land use, geology and geomorphology, water quality, streamflow and water use, and instream habitat conditions for salmonids. It will also contain hypotheses about watershed factors that contribute to limiting factors for fish.

- Recommendations for management and restoration to address limiting factors.
- Recommendations for additional monitoring to improve the assessment process.
- A CD developed through the Institute for Fisheries Resources which uses the Klamath Resources Information System tool to store data, provide a regional bibliography of watershed studies and reports, present NCWAP analyses, maps and other products, and store community based data over time.

In order to develop products that the public and agencies will use, we developed a set of principles to guide how we implement the NCWAP assessment process. The following principles are intended to provide a comprehensive, flexible, and reliable body of information for each basin assessment. First, we are committed to providing information for several purposes, including products that meet needs which have been identified by landowners, agencies that work with them, watershed groups, and others. We will work with local stakeholders to help focus our assessments and conduct it in a cooperative and iterative fashion, incorporating relevant information that is available to us. In order to provide a comprehensive, reliable and yet flexible process, we will use a consistent approach to compiling existing data, standardized protocols for collecting new data, and an adaptive methodology for analyzing information that allows for inherent differences among watersheds in conditions, concerns, and availability or access to information. We will manage the process to ensure interdisciplinary analysis by the interagency team to identify limiting factors for salmonid fisheries and potential contributions by various watershed conditions to the watershed's suitability for salmon habitat. Finally, we will provide full and timely public access to all data, products, and reports on hard copy, on-line, and on CD.

The assessment process for each watershed consisted of six basic steps:

Step One: Scoping. The basin team met several times with stakeholders to identify watershed problems or concerns, local assessment interests, existing data and gaps, and opportunities to work with local interests to collect and analyze data to implement the assessment.

Step Two: Data Compilation and review. The team compiled existing photos, maps, studies, databases and other types of information. They were screened for quality, using the program's quality control protocols, and for their relevance to the assessment's critical questions and EMDS mode, considering issues such as original intent of studies, methods, scope and scale.

Step Three: Preliminary analysis. The team developed an interdisciplinary assessment of the watershed's condition, using EMDS to the extent possible, to analyze watershed suitability for salmon habitat and factors potentially limiting fish production. This step helped to identify significant data gaps in order to focus additional field data collection efforts and additional analyses.

Step Four: Fieldwork. Agencies conducted fieldwork as resources and timing allowed to answer critical questions, develop landslide and sediment maps, and run the EMDS model. This included verification of existing data, imagery or photo-based analyses; installation of stream gauges; and collection of new data to fill critical gaps. Throughout this process, there was coordination with local groups and landowners on access to private property and other matters.

Step Five: Analysis of Additional Data and Limiting Factors. This step included both analysis of data by individual team members and interdisciplinary analytical processes such as map development, analysis of new field data, GIS-based spatial analyses of multiple types of data, running EMDS with new data, and refinement of hypotheses about linkages among watershed factors and suitability for salmon.

Step Six: Synthesis Report, Recommendations, and Information Access: The team pulled all the information together into a report that describes the overall condition of the watershed for fisheries, limiting factors for fish, and potential linkages among watershed factors and fish habitat conditions, and which contains recommendations for management, restoration and monitoring. The report will be made available in hard copy (limited quantities), on the KRIS CD, and on-line for review by the public.

ASSESSMENT SCHEDULE

Five watersheds were slated for NCWAP's first year on two completion schedules:

Redwood Creek, Mattole River, Gualala River

- Nov 1, 2001 – draft assessment report to contributors for review
- Nov 15, 2001 – draft assessment report to agency directors for internal review
- Dec 1, 2001 – briefings of agency directors completed
- Feb 1, 2002 – draft assessment to the Legislature, followed by release to the public
- Apr 1, 2002 – public review completed
- May 1, 2002 – final assessment to the Legislature

Albion River, Big River

- Mar 1, 2002 – draft assessment report to contributors for review
- Mar 15, 2002 – draft assessment report to agency directors for internal review
- Mar 15, 2002 – briefings of agency directors completed
- Apr 1, 2002 – draft assessment to the Legislature, followed by release to the public
- Jul 1, 2002 – public review completed
- Sept 1, 2002 – final assessment to the Legislature

APPENDIX 2

PUBLIC PROCESS SUMMARY

The assessment began with outreach to the Gualala River Watershed Council's Watershed Coordinator. The GRWC's mission statement (Appendix) provided a framework to compare the goals of the program with the goals of landowners and interested public in the watershed. A short presentation of the NCWAP was done by Water Quality and Resources Agency on September 19, 2000, was followed by input from the audience, which provided direction on the process of assessment, especially regarding interactions with the Council and landowners. Numerous small meetings with the Coordinator and others ensued as details were discussed regarding access, data sharing, and the assessment process. Individual agencies presented their approaches to the assessment, and the Project Lead provided occasional updates on the progress of the assessment to the GRWC. Interactions with private landowners as well as industrial timber landowners occurred on an as-needed basis.

The primary focus of the GRWC is "…to communicate about the ecology and land uses in the Gualala River watershed aimed at …" promoting educational opportunities about watershed functions, encouraging stewardship of the natural resources, maintaining and improving watershed resource values, influencing land use decisions, and addressing the TMDL, while buidling upon existing sound resource management efforts and "maintaining the economic viability of landowners, resource management and recreational uses." The full mission statement is reproduced at the end of this summary.

The NCWAP thrust to assess conditions and provide recommendations for improvements, especially with respect to anadromous salmonids, is supportive of the GRWC's mission. Primary concerns expressed by the Council were related to:

1. Access – members asked that the agencies coordinate on requests for access to avoid asking a landowner for access many times, as well as multiple trips by agencies
2. Access – the Council suggested that NCWAP go through the Coordinator for access requests
3. Field presence – there was concern that agency staff would take enforcement actions if they observed a problem on private property
4. TMDL – most of the assessment would be after the development of the TMDL for the watershed and concern was expressed regarding coordination with the TMDL and timing
5. Involvement – the Council wanted to be involved in the assessment, but recognized the need for NCWAP to meet independently initially
6. Involvement – the Council also expressed a desire to assist in data collection and analysis, as well as have an opportunity to review the assessment in draft form

NCWAP enjoyed a healthy relationship with the GRWC and responded to those concerns as follows:

1. and 2. NCWAP agencies and programs coordinated on access requests to the extent possible. It was necessary for separate requests to be made in some instances due to the timing and areas that different agencies needed to access, e.g., DMG needed access first for groundtruthing maps of geologic and erosional features, DFG needed access to stream corridors throughout the entire watershed later in the summer. NCWAP was in close contact with the Coordinator during access requests, the Coordinator providing information on landowner willingness and contact. The DFG even contracted with a GRWC member to arrange access in the South Fork subwatershed. While the process had a few problems, they were minor and easily resolved.

3. Regulatory staff explained the discretion they have in taking enforcement, and that landowners providing access would be contacted and given opportunity to resolve any blatant and/or obvious intentional violations first. Minor problems noted on a landowner's property would be brought to their attention, however no enforcement was contemplated. No enforcement actions were taken as a result of NCWAP field presence.

4. To the extent we were able, the TMDL Development Team of the NCWQCB and the NCWAP coordinated on data collection and analysis. A considerable amount of the analysis performed for the TMDL Technical Support Document was used in the assessment, and appears in this assessment report.
3. and 6. The NCWAP involved interested GRWC members in the data collection and assessment process, sharing equipment and expertise, and data products in draft form. GRWC members assisted in data collection, data analysis, and review of products, contributing a significant amount of information and analysis to the process.

   The NCWAP expressed the desire to have contributors review the draft assessment to ensure their data were used appropriately and to provide additional input and analysis. The report production schedule was revised to allow the GRWC and other contributors the opportunity to review the draft assessment prior to internal agency review. This provided an opportunity for contributors to respond to the NCWAP on issues of data use and interpretation, and conclusions drawn from that.

- GRWC Mission Statement – February 2001

The Gualala River Watershed Council (GRWC) is a forum of Gualala River landowners, resource managers, agencies, and interested parties—a place to communicate about the ecology and land uses in the Gualala River watershed aimed at achieving the following goals:

- building upon existing efforts that support sound resource management,
- promoting educational opportunities about watershed functions,
- Maintain and improve watershed resource values,
- Encourage stewardship of the natural resources,
- Influence land use decisions in the watershed,
- Address the Clean Water Act Section 303 (d) "Water Quality Attainment Strategy" (TMDL), while maintaining the economic viability of landowners, resource management and recreational uses.

The GRWC will work towards attaining these goals by identifying and defining problems to address watershed assessment, developing an enhancement plan, and implementing solutions on a prioritized basis using sound science, common sense, and a cooperative, collaborative approach to maximize all the goals of all the parties to the extent possible.

<u>The more widely attended meetings:</u>

September 19, 2000 – initial rollout of the NCWAP assessment for the Gualala, including significant input from the GRWC

December 20, 2000 – meeting with large timber landowners about the upcoming TMDL and NCWAP assessment and data sharing and access for field work

January 16, 2001 – DMG and CDF presentations on their analysis and products for the NCWAP assessments

February 2, 2001 – NCWAP representatives and Gualala Technical Advisory Committee meeting in Ukiah

October 16, 2001 – update on the NCWAP assessment process, including some analysis products

APPENDIX 3

ASSESSMENT METHODS SUMMARY

Fish and Game Methods
This assessment correlated habitat loss trends from CDFG stream surveys spanning different time periods throughout tributary sub-basins, with land use patterns, and noted direct sedimentation inputs by timing with peak flow events. Scale of shade canopy depletion is compared between 1942 and present. Current habitat conditions (pool depth and frequency, % shade canopy cover) are geographically shown to infer relationships of current fisheries populations with, (1) stream temperatures, (2) sedimention (McNeil sampling, embeddeness, and substrate type (D_{50}). and (3) unstable areas and slide locations. Changes in fluvial geomorphology shows timing and direction of sediment transport downstream.

Water Quality Methods
The RWQCB compiled and evaluated existing data that were available as well as collected some new water quality data. The data analysis included in this assessment by RWQCB is for basic water chemistry, water temperature, and sediment parameters. The data gathering, data collection, and data analysis techniques are detailed in our methods manual, NCRWQCB (2001).

Data Gathering
Data gathering is the process of compiling existing data from Regional Water Board files, other agency files, and other sources. The Regional Water Board has several types of water quality information sources within its office, all of which were evaluated for inclusion into the assessment: Timber Harvest Plan files, water quality monitoring files, TMDL files, grant files, EIRs and other reports. Sources outside the office included data and reports from other agencies (including water rights and diversion information), US EPA's StoRet water quality database, watershed groups, landowners, and public interest groups. As data were gathered, the location and general characteristics of the data were catalogued in a computerized database. Catalogued data included non-water quality data related to the watershed assessment that we made available to the other NCWAP agencies as requested.

Data Collection
RWQCB staff collected water quality measurements three times during 2001 in the Gualala River watershed. Sample collection and analysis was in accordance with methods used by USGS and USEPA. Those methods are further explained and referenced in the RWQCB's NCWAP methods manual (NCRWQCB 2001). While staff had hoped to collect stream channel information, such as pebble counts, we were unable to accomplish this due to access and resource constraints. However, the Gualala River Watershed Council (GRWC) in cooperation with the Gualala Redwoods, Inc. (GRI) collected those types of data at a number of locations in the watershed. Additionally, a GRWC/RWQCB joint effort in temperature monitoring resulted in additional sites being monitored as well as the collection of air temperature data for future modelling activities.

Data Analysis
The data were computerized into formats appropriate for the information, e.g., spreadsheets for dissolved oxygen, flow, temperature. Analysis of the data was specific to the data type and its quality. For example, water temperature data from continuous data loggers were evaluated from raw data plots (when available) over time and cumulative distribution plots against water quality criteria or water quality objectives (WQOs) to determine frequency of exceedances (percent of observations and number of days), duration of exceedances (how many hours was a particular standard exceeded in a day), and maximum daily excursions. Additionally, summary statistics were compared to the proposed limiting factors thresholds: MWAT, the maximum 7-day floating average temperature for the summer season for a site and the Seasonal Maximum for a site. The thresholds were 50-60 F proposed as "fully

supportive of salmonids" for MWAT, and 75 F proposed as lethal for salmonids. Where we did not have the full raw data set for continuous temperature measurements, we evaluated only the summary statistics.

For sediment parameters, we used data available for streambed cores and pebble counts. The primary metrics were: D_{50}, median particle size from pebble counts, and percent fine material in core samples <0.85 mm and <6.4 mm. We compared D_{50} values to Knopp (1993), who studied north coastal streams and found in 18 index streams (streams with little or no land management activities for 40 years) D_{50}s ranging from 37 to 183 mm, with a mean of 69 mm. Core data were compared to the proposed Gualala TMDL targets of less than 14% and less than 30% for particle sizes of 0.85 and 6.4 mm, respectively.

As the synthesis of data proceeded, these data were evaluated with respect to influential factors to the extent they were available, such as canopy for temperature and land use and erosional feature along with fluvial geomorphology for sediment. To the extent data arrays, staffing, and time limitations allowed, it was an interdisciplinary effort in recognizing and hypothesizing the linkages and understanding the data more fully and in a broader context.

Data Quality and Limitations

We evaluated existing data for quality with respect to the assessment, and new data collections were at a level to ensure utility in the assessment.

- Water temperature and stream channel measurements provided by the GRWC and GRI were collected with acceptable methods and quality assurance and control for use in the assessment. However, we were unable to evlauate the data in raw form in most cases because it either was not provided or staffing and time constraints prevented that analysis
- NCRWQCB's water chemistry analysis was limited to available USEPA StoRet data for the period April of 1974 to June of 1988 at three locations, and three samples obtained by NCRWQCB at five locations in 2001. The sampling frequency and small number of locations did not allow for any detailed temporal analysis.
- Pesticide data were not available from StoRet, nor collected in the NCRWQCB sampling of 2001.
- Collection of additional water quality data on daily dissolved oxygen, pH, conductance, and temperature at locations near the confluences of major tributaries did not occur due to access limitations.
- NCRWQCB analyzed water temperature and in-channel data supplied by the GRWC and GRI for the period from 1992 to 2001. Not all locations received sampling throughout that period, limiting the ability to compare across years and among sites.
- In-channel data and some most temperature data were provided as summary statistics (medians, means, maxima), limiting the ability to factor variability into the analysis, and not allowing for independent checks on the data quality. As such, the analyses and subsequent assessment are limited in scope.
- Analysis of temperature information is without knowledge of the extent of a thermal reach upstream of the continuous data logger.
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- The water quality data gathered in the past and more recently in 2001 were adequate for the analysis performed and provide a general sense of the basic water chemistry.
- Turbidity and suspended solids data were not available, though critical to water quality assessment.
- The primary limitations to the data we evaluated were related to matters of scale—that is, the representativeness of a measurement in a specific location with respect to characterizing a subwatershed. In that context, the data often determine the coarseness of the assessment as some data are more appropriately applied over a larger area than others.

Although there is controversy regarding the utility of streambed substrate data, pebble counts and core samples can provide a perspective on the composition and dynamics of the streambed. Conditions in a riffle may vary considerably, requiring large sample sizes to quantify the conditions for salmonids. However, the pebble count and core sample results for the Gualala River watershed were useful in providing an idea of streambed conditions and to add validity to other observations, such as the embeddedness and dominant particle sizes data from habitat surveys.

Methods used by GRI and GRWC

Riparian condition was inventoried by GRI and GRWC in two ways:

Canopy cover percent was measured with a vertical densiometer during the watershed-monitoring program conducted by GRI and GRWC from 1998 to 2001. Measurements were taken every 200' along the monitoring reach at the center of channel, left and right bank full and 50' into the riparian zone from bank full on the left and right bank. Center of channel measures the effect of the riparian zone on the stream. The measurement taken 50' inside the riparian zone, measures the condition of the riparian forest. This is important because in the wider channels it may be impossible to significantly affect the channel with riparian shade. Current forest practice rules target 85% canopy cover as a desirable post harvest condition within 75' of bank full.

A riparian vegetation inventory was conducted during the watershed-monitoring program conducted by GRI and GRWC from 1998 to 2001. Inventory plots using the Forest Projection System inventory design were located on both sides of the channel every 200'. Tree size, species, live crown ratio, distance to the stream were measured. In addition, understory vegetation, snags and down logs were measured.

For biotic parameters GRI used electro shocking conducted between 1988 and 2001 by DFG, snorkel surveys conducted by GRI between 1997 and 2001 and Macroinvertebrate surveys conducted by GRI in 2000.

The snorkel surveys are principally a presence absence survey with a rough estimate of abundance by age class. Dennis Halligan, a fisheries biologist working for Natural Resource Management, Inc, conducted all the surveys.

The macroinvertebrate samples were taken by Jon Lee, a third party expert and analyzed in his state certified lab. The use of macroinvertebrates as indicators of stream condition is a well accepted and long established method (Erman, N, 1991). An inventory of macroinvertebrate fauna in stream riffles can measure changes in chemical and physical stream properties. These changes ultimately determine the presence and distribution of resident biota (Usinger, 1956). Such an inventory is indicative of current as well as past environmental conditions. This method of sampling emphasizes the collection of bottom dwelling insects, which are relatively fixed in their habitat, unlike fish or plankton which can move to more favorable conditions (Usinger, 1965).

GRI used the "California Stream Bioassessment Procedure" (Cal. Dept. of Fish and Game, 1999). The following metrics (measures based on benthic macroinvertebrates in a benthic sample) suggested by the California Stream Bioassessment Procedure are currently being used to monitor streams on GRI properties.

Taxa Richness

This is a measure of the total number of distinct taxa within a sample. Macroinvertebrates are determined to the lowest practical taxonomic level (generally genus)as suggested by the CAMLnet Standard Taxonomic Effort (Cal. Dept. of Fish and Game, 2000). Taxa richness generally decreases with decreasing water quality (Weber, 1973; Resh and Grodhaus, 1983). (((Taxa richness generally increases with increasing water quality, habitat diversity, and/or habitat suitability (Plafkin et al.1989).))) The following table will help describe the quality of the stream in the coastal Mendocino region when Taxa Richness is used as a metric. (Personal Com. Jon Lee, 1994; Harrington et al., 1999) :

	Poor	Average	Good
Richness	<26	26 to 35	>35

Community Diversity Index

The most common measures of stream health are diversity indices. Diversity indices measure species richness rather than abundance. A healthy stream should exhibit high diversity evidenced by a large number of taxa without any one taxon dominating.

The Simpson diversity index is the most commonly used diversity index when addressing aquatic communities (Magurran, 1988, Rosenberg and Resh, 1992).

The Simpson index is based upon species dominance. The Simpson diversity index ranges from 0 - 1.0. As the index approaches 1.0, the more diverse the sample is thought to be. The following table will help describe the quality of the stream when the Simpson index is used (Personal Com. Jon Lee, 1994):

	Poor	Average	Good
Simpson Diversity Index	.7 to .79	.8 to .89	.9 to 1.0.

Percent Dominant Taxon

The Percent Dominant Taxon is the ratio of individuals in the most abundant taxon to the total number of organisms in the sample. A sample dominated by relatively few taxa would indicate environmental stress, as would a sample composed of several taxa but numerically dominated by only one or two. An abundance of taxa with a fairly equal distribution of individuals within the sample is indicative of community balance.

The following table will help describe the health of the stream when using Percent Contribution of the Dominant taxa (EPA 444/4-89-001) :

	Poor	Average	Good
% Contribution of Dominant Taxa	> 39 %	39 - 15 %	<15%

Biotic Index

The Hilsenhoff Index is a biotic index. This index weights the relative abundance of each taxon in terms of its organic pollution tolerance to determine a community score. Generally the higher the score the poorer the water quality (Hilsenhoff, 1982).

Index	Condition
0.85 to 1.75	Excellent
1.76 to 2.25	Very Good
2.26 to 2.75	Good
2.76 to 3.50	Fair
3.51 to 4.25	Poor
4.26 +	Very Poor

A tolerance value based on the Hilsenhoff Biotic Index is currently being used in the Pacific Northwest. Taxa tolerant of organic enrichment are also generally tolerant of warm water, fine sediment, and heavy filamentous algal growth (Wisseman 1996). The tolerance value is based on a scale of 0 (intolerant) to 10 (very tolerant).

The value is expected to increase with a stressed environment. The following table will help describe the health of a stream when using this tolerance value (Harrington et al. 1999):

	Poor	Average	Good
Tolerance Value	<4.6	4.6 to 3.1	>3.1

Abundance

This is rough estimate of the total number of macroinvertebrates per sample and hence per unit area of stream. Very low abundances would be considered a negative when evaluating the relative health of a stream.

APPENDIX 4

DATA CATALOGUE AND BIBLIOGRAPHY

October 16, 2001
(grouped by agency)

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4/8/1999, Groshong Ridge THP
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9/28/1998, Pepperwood '98 THP
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11/24/1997, Rockeye THP
5/27/1999, Signal Ridge THP
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APPENDIX 5

FISHERIES HABITAT AND POPULATION INFORMATION

APPENDIX 6

HYDROLOGY

APPENDIX 7

GEOLOGIC SUMMARY AND FLUVIAL GEOMORPHOLOGY

APPENDIX 8

LAND USE HISTORY FOR THE GUALALA RIVER WATERSHED

Located immediately north of the Bay Area, the Gualala Watershed has the longest span of historical use compared to other North Coast Watersheds. Logging of the virgin old growth redwood forest began during the mid 1800s. The first documented account dates to 1862 in lower portions of the watershed near coastal ramp and port facilities. There was concentrated demand of the resource after the 1906 earthquake and rebuilding of San Francisco. A rail line extended along the South Fork to Gualala from the Santa Rosa Area.

The first logging methods used oxen teams to move large old growth redwood logs to terminal points of lateral connecting raillines. Watercourses were frequently used as skid paths to move logs downslope. Natural pool structure was removed during construction and use of watercourses as skid ramps. Log planking of the streambed was commonly used to ease frictional constraints. Construction of splash dams represented a significant alteration of stream channel morphology. These activities undoubtedly left many areas vulnerable to major erosional impacts by infrequent large storm events.

Lateral raillines extending to the interior had to be built on a low elevation rise following an even sideslope contour. This necessitated massive cut and fill excavation operations by a mobile train mounted steam shovel. These worked at the endpoint of the newly constructed railline. Although wood trestles were built over larger watercourses, smaller watercourses were crossed by wood and earth fill. This frequently dammed the watercourse over time, and failed altogether. Many sections of the lateral raillines continue to be used today as part of the current permanent and seasonal road network with watercourse crossings upgraded and repaired.

The introduction of the stream donkey by the turn of the century reduced ground impacts by cable pulling large logs from fixed locations. Elaborate pully systems enabled cable winching over larger distances. These operations did not disturb the ground to the extent of more recent tractor operations characterized by large scale slideslope excavations and skid trail networks.

The gasoline powered crawler tractors made their appearance in the northcoast in the late 1920s. At first, these were slow, limited to near level terrain, and subject to repeated breakdowns. Steam donkey methods continued to operate on moderate to steep terrain. However, refinement of military tank designs during World War II immediately transformed tractor yarding equipment as reliable and economical timber harvesting methods. Improvements in transmission, suspension, and engine horsepower in the Russian built T-34 tanks and German Mark III Panther tanks in the early 1940s enabled heavily armored equipment to rapidly move over varied terrain. The development of the diesel engine, built into the Mark VI King Tiger Tank, powered even heavier loads. Early versions of the D-8 and D-10 tractors, using the same track mounts and suspension systems, and powered by diesel engines, were ideally suited for moving large diameter logs over difficult terrain. This equipment was readily maneuverable, enabling large areas to be worked over in short time periods. Rail line networks were quickly abandoned to diesel powered log trucks operating along seasonal roads.

The 1936 photos show the Gualala Watershed long dormant during the Great Depression. The mid sized second growth stands shown in these photos indicate that old growth logging by steam donkey had ceased shortly after the turn of the century. There are no interior logging roads away from the coast. This indicates that the old railline network was unused and abandoned during the Great Depression.

Increased demand for lumber products during the 1950s coincided with the widespread deployment of D-8 and D-10 sized heavy tractors throughout the watershed. By 1952, an ample timber supply consisted of larger diameter second growth redwood regenerated from mid 1800 old growth era harvesting, and old growth Douglas-fir in central and upslope locations.

Between 1952 and 1960, tractor method harvesting extended in a broad sweep from the upper reaches of the North Fork, east through the central and upper reaches of Rockpile and Buckeye Cks, and throughout lower and middle reaches of Wheatfield Fk. Harvest operations followed straight parcel lines irregardless of watercourse condition or difficult terrain. Roads often followed the stream channel to enable downslope skidding. Many roads had steep gradients designed to access all positions of the sideslope. Skid trails frequently followed or crossed ephemeral stream channels. Landings were often located in or adjacent to watercourses. These were built by pushing wood debris into channel, and overtopped by dirt fill. Across steep terrain, skid trials cut deep into the sideslope, creating a terraced effect.

By 1964, tractor harvesting had continued at an active pace to comprise a majority and in some areas, most of the timbered areas in the west and central reaches of the watershed. In the mixed conifer –oak woodland areas in the north east and east areas of the watershed, a considerable portion of the original Douglas-fir stands had been harvested. These had occupied north slopes and riparian areas on private ranch parcels. Prolonged cattle grazing in these areas after harvest prevented timely reestablishment of canopy cover over fish bearing watercourses, elevating stream temperatures.

The lack of any erosion control facilities installed throughout large areas of the watershed, coupled with the uncontrolled installation of fills and failure to remove fills adjacent to watercourses, left the entire watershed particularly vulnerable to the 1964 flood event. During a period of one week in December 1964, the intense prolonged runoff caused massive erosion downcutting, slides, and washing of soil and debris into watercourses by which essentially characterizes sediment loads and aggregation points still observed today. The June1965 Cal Trans photos taken at 1200 scale clearly show repeated stream channel meandering patterns through wide, flat areas of buried stream pools. This indicates deep channel aggradations. Roads following the stream channel repeatedly failed as fill sidecast washed out during peak flows. Debris slides above and below roads were frequent. Deep blow outs through landings built over channel are numerous throughout the 1965 photos. There were frequent watercourse diversions onto roads and skid trails. Although the U.S. Geological Survey cumulative peak flow gauge along the lower South Fork shows 1955-56 cumulative flows slightly higher than 1964-65, far fewer areas of the watershed were logged by 1955 compared to 1964 (See Logging History Maps). .

After 1964, harvest operations resumed at an active rate in the lower and middle reaches of the North Fork and entire Little Nork Fork areas to remove most of the available timber base in these areas by 1973. Other areas of mature Douglas-fir in (1) higher elevation areas and (2) east reaches of the watershed, were harvested during this time. Only pocket stands and scattered larger timbered blocks remained. Road and landing locations continued to be located low on the sideslope, frequently following the stream channel. Subsequent landing blowouts and road failures have been documented along the Little North Fork and central North Fork. There were large storm events in 1972 and 1975.

After 1973, logging operations had slowed. Smaller selection method harvests were predominant. By this time, tractor yarding methods changed to maintain equipment exclusion zones and minimum vegetation retention standards adjacent to watercourses per 1973 Forest Practice Rules. New road locations were moved upslope. The new forest practice rules limited the cutblock size, creating smaller logged areas.

In the 1990s, harvest activity increased. Smaller but numerous clearcut blocks appear in the redwood lowland areas of the Gualala Redwoods ownership. Throughout the watershed, cable method yarding appears with new road construction now moved to upslope and ridgeline locations. Many sections of the older seasonal roads following the stream channel are either abandoned or removed. During the mid 1990s, Coastal Forestlands (formerly R&J Timber Co.), purchased by Pioneer Resources in 1998, submitted numerous seed tree overstory removal/ dispersed harvest THPs, covering large areas but removing scattered single trees and remnant stands left from 1960s era entries. Agency review of these THPs clarified road upgrade work requirements to repair erosion conditions of pre-1973 operations. There has been little harvesting in these areas since 1998. 95% of the entire Gualala watershed is privately owned (see Ownership Distribution Map, pg).

APPENDIX 9

WATER QUALITY SUMMARY

Beneficial Uses Of Water

Existing water quality requirements are described in the *Water Quality Control Plan for the North Coast Basin* (1996) (Basin Plan), which is the tool for comprehensive water quality planning as set forth in both California's Porter-Cologne Water Quality Control Act and the federal Clean Water Act. Among other things, the Basin Plan describes the existing and potential beneficial uses of the surface and ground waters in each of the watersheds throughout the North Coast Region. It also identifies both numeric and narrative water quality objectives, the attainment of which is considered essential to protect the identified beneficial uses.

The Basin Plan identifies the following existing beneficial uses of water in the Gualala River basin:

- Municipal and Domestic Supply (MUN)
- Agricultural Supply (AGR)
- Industrial Service Supply (IND)
- Recreational Uses (REC-1 & REC-2)
- Commercial and Sport Fishing (COMM)
- Cold Freshwater Habitat (COLD)
- Wildlife Habitat (WILD)
- Rare, Threatened, or Endangered Species (RARE)
- Migration of Aquatic Organisms (MIGR)
- Spawning, Reproduction, and/or Early Development (SPWN)
- Estuarine Habitat (EST)

The beneficial uses identified above as COMM, COLD, MIGR, WILD, RARE, SPWN, and EST are all related to the Gualala River watershed's cold water fisheries. Beneficial uses associated with the cold water fisheries are among the most sensitive in the watershed. As such, protection of these beneficial uses is presumed to help protect any of the other beneficial uses that might also be harmed by sedimentation.

The COMM beneficial use applies to water bodies in which commercial or sport fishing occurs or historically occurred for the collection of fish, shellfish, or other organisms, including, but not limited to, the collection of organisms intended either for human consumption or bait purposes. The COLD beneficial use applies to water bodies that support or historically supported cold water ecosystems, including, but not limited to, the preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates. The WILD beneficial use applies to water bodies that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources. The RARE beneficial use refers to water bodies that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened or endangered. The MIGR beneficial use applies to water bodies that support or historically supported the habitats necessary for migration or other temporary activities by aquatic organisms, such as anadromous fish. The SPWN beneficial use applies to water bodies that support or historically supported high quality aquatic habitats suitable for the reproduction and early development of fish. The EST beneficial use applies to water bodies that support or historically supported estuarine ecosystems, including, but not limited to, the preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds).

Water Quality Objectives

The Porter-Cologne Water Quality Control Act specifies that each regional board shall establish water quality objectives which, in the regional board's judgment, are necessary for the reasonable protection of the beneficial uses and for the prevention of nuisances. The water quality objectives are considered to be necessary to protect those present and probably future beneficial uses stated above and to protect existing high quality waters of the state. As new information becomes available, the Regional Water Board will review the appropriateness of existing and proposed water quality objectives and amend the Basin Plan accordingly.

The following is a summary of water quality objectives for the Gualala River watershed according to the Basin Plan, as amended in 1996.

NARRATIVE WATER QUALITY OBJECTIVES

Objective	Description
Color	Waters shall be free of coloration that causes nuisance or adversely affects beneficial uses.
Tastes and Odors	Waters shall not contain taste- or odor-producing substances in concentrations that impart undesirable tastes or odors to fish flesh or other edible products of aquatic origin, or that cause nuisance or adversely affect beneficial uses.
Floating Material	Waters shall not contain floating material, including solids, liquids, foams, and scum, in concentrations that cause nuisance or adversely affect beneficial uses.
Suspended Material	Waters shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses.
Settleable Material	Waters shall not contain substances in concentrations that result in deposition of material that causes nuisance or adversely affect beneficial uses.
Oil and Grease	Waters shall not contain oils, greases, waxes, or other materials in concentrations that result in a visible film or coating on the surface of the water or on objects in the water, that cause nuisance, or that otherwise adversely affect beneficial uses.
Biostimulatory Substance	Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses.
Sediment	The suspended sediment load and suspended sediment discharge rate of surface water shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.
Temperature	The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses. At no time or place shall the temperature of any COLD water be increased by more than 5°F above natural receiving water temperature.
Toxicity	All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life.
Pesticides	No individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses. There shall be no bioaccumulation of pesticide concentrations found in bottom sediments or aquatic life.
Chemical Constituents	Waters designated for use as agricultural supply (AGR) shall not contain concentrations of chemical constituents in amounts which adversely affect such beneficial uses.
Radioactivity	Radionuclides shall not be present in concentrations which are deleterious to human, plant, animal or aquatic life nor which result in the accumulation of radionuclides in the food web to an extent which presents a hazard to human, plant, animal, or indigenous aquatic life.

Numeric water quality objectives

Objective	Description
Turbidity	Turbidity shall not be increased more than 20 percent above naturally occurring background levels.
pH	The pH of waters shall always fall within the range of 6.5 to 8.5.
Dissolved Oxygen	At a minimum, waters shall contain 7.0 mg/L at all times. Ninety percent of the samples collected in any year must contain at least 7.5 mg/L. Fifty percent of the monthly means in any calendar year shall contain at least 10.0 mg/L.
Bacteria	The bacteriological quality of waters of the North Coast Region shall not be degraded beyond natural background levels. Based on a minimum of not less than five samples for any 30-day period, the median fecal coliform concentrations in waters designated for contact recreation (REC-1) shall not exceed 50/100 ml. Nor shall more than ten percent of total samples during any 30-day period exceed 400/100 ml.
Specific Conductance	Ninety percent of the samples collected in any year must not exceed 220 micromhos at 77°F. Fifty percent of the monthly means in any calendar year shall contain at least 125 micromhos at 77°F.
Total Dissolved Solids	Ninety percent of the samples collected in any year must not exceed 115mg/L. Fifty percent of the monthly means in any calendar year shall contain at least 75 mg/L.

Prohibitions

In addition to water quality objectives, the Basin Plan includes two discharge prohibitions specifically applicable to logging, construction, and other associated non-point source activities. The prohibitions state:

- The discharge of soil, silt, bark, slash, sawdust, or other organic and earthen material from any logging, construction, or associated activity of whatever nature into any stream or watercourse in the basin in quantities deleterious to fish, wildlife, or other beneficial uses is prohibited.
- The placing or disposal of soil, silt, bark, slash, sawdust, or other organic and earthen material from any logging, construction, or associated activity of whatever nature at locations where such material could pass into any stream or watercourse in the basin in quantities which could be deleterious to fish, wildlife, or other beneficial uses is prohibited.

Development and implementation of a Total Maximum Daily Load (TMDL) is one means of attaining water quality objectives and protecting beneficial uses in the Gualala River. The TMDL program is required by Section 303(d)(1)(A) of the Clean Water Act (CWA) that states, "Each State shall identify those waters within its boundaries for which the effluent limitations . . . are not stringent enough to implement any water quality standard applicable to such waters." The same part of the CWA also requires that the State "establish a priority ranking for such waters, taking into account the severity of the pollution and the uses to be made of such waters." Gualala River was included on the 1996 and 1998 lists based on the finding that sedimentation is, in part, responsible for the impairment of the cold water fisheries. Section 303(d)(1)(C) of the CWA requires that "Each State shall establish for the waters identified in paragraph (1)(A) of this subsection, and in accordance with the priority ranking, the total maximum daily load..."

"As part of California's 1996 and 1998 303(d) list submittals, the North Coast Regional Water Quality Control Board (RWQCB) identified the Gualala River as water quality limited due to sediment loading and designed the watershed as a high priority for TMDL development. The RWQCB published a Technical Support Document for the TMDL in 2001 (CWQCB 2001).

Gualala River Watershed – Discharger Information

The Annapolis Milling Company

The Annapolis Milling Company, Incorporated, owns and operates a conventional sawmill near the town of Annapolis in western Sonoma County. The facility is located in the NW1/4, SE1/4 of section 7, T1ON, R13W, MDB&M. The facility consists of a sawmill, equipment maintenance shed, and a five acre dry log deck.

Stormwater runoff from the log deck flows to the west towards Grasshopper Creek and to the east towards an unnamed tributary of Buckeye Creek, both major tributaries of the South Fork Gualala River. Domestic waste is discharged to a septic tank/leachfield system. Steam cleaning waste is discharged onto the ground. Log deck cleanup/solid waste is disposed of at the Sonoma County landfill near Annapolis. Wood shavings and sawdust is sold as landscaping material. The Regional Board adopted Waste Discharge Requirements Order No. 85-176 on December 5, 1985, for this facility.

Comments or Issues -
There is a former underground storage tank (UGST) site at the sawmill which is being handled by the Sonoma County Health Department. The tank was removed in1989, and in March 1990 a remediation workplan was approved and soil excavation began.
In February 1995, staff reported that this facility had not submitted any Self Monitoring Reports since July of 1994, which could result in a violation.
In April 2000, staff inspection found that mill operations were substantially unchanged over the past decade. Bark waste is now sold to reuser in cloverdale, and vineyards are being planted over some of the area formerly used for decking logs.
Recent violations consisted of repeatedly failing to record discharge observations. Several staff inspections in 2000 noted that there was no copy of the storm water pollution prevention plan, storm water permit, or monitoring program available on site.

Mendocino County, South Coast Solid Waste Disposal Site. (SWDS)
The County of Mendocino is the owner and operator of a Class II-2 solid waste disposal site located approximately five miles east of Highway 1 in the S1/2 of Section 4, T11N, R15W, MDB&M. The disposal site property contains 47 acres while the active portion of the disposal site included approximately 10 acres located adjacent to the (Little) North Fork Gualala River. The landfill is unlined and has been in operation since 1970. The landfill is located over the San Andreas Fault and borders the Little North Fork of the Gualala River, located approximately 50 feet southwest of the site. Land within 1000 feet of the disposal site is unimproved forest and range land. The discharger is operating the site as a fill and cover operation with waste being placed in layers behind a compacted earth barrier that is keyed into the native soils. Surface drainage is diverted around the fill area. This disposal site is now in the process of closure.

Comments or Issues –
A staff inspection of the site on February 26, 1987 revealed that a pond used to control sediment discharges from the site was filled to capacity with a liquid that was confirmed to be leachate. The liquid was flowing into the pond from a seep at the toe of the active face of the fill. The pond is located less than a quarter mile from the Little North Fork Gualala River.
In February 1994, staff reported the violation of a broken leachate tank which discharged 2000 gallons to surface water, and a sediment pond discharge pipe triggered a small mudslide to creek.
In April 1995, staff indicated a need to resolve the groundwater separation issue and VOC's reported in monitoring wells.

In May 2000, staff inspection reported that a berm had recently been constructed around the active face of a site to contain leachate. A broken leachate pipe was evident within the berm. The timing of berm placement with respect to origin of leachate flow may have been delayed, and might not have been installed soon enough.

Gualala Community Services District Wastewater Treatment and Disposal Facilities
In January 1992, the Gualala Community Services District submitted a report of waste discharge for the operation of a new wastewater treatment plant located in the NW ¼ of Section 26, T11N, R15W, MDB&M, South of the

Community of Gualala in Northwest Sonoma County. The treatment plant is located in the watershed of the Gualala River and the Pacific Ocean.

The discharger proposes to treat wastewater to a secondary level using an aerated pond and polishing clarifier. Solids from this treatment process are retained in a sludge basin and will be removed to an approved disposal site on a periodic basis. Following treatment, the water is stored in ponds and used to irrigate the Sea Ranch Golf Links.

Comments or Issues -
July 1992, an estimated 11,000 gallons of secondary treated, filtered and disinfected wastewater was discharged to Salal Creek.
October 1992, an estimated 40,000 gallons of secondary treated, filtered and disinfected wastewater was discharged to Salal Creek.
January 1993, an estimated 20,000 gallons of treated, un-disinfected wastewater was discharged to a tributary of the Gualala River, and the Gualala River.
May 1993, an estimated 100,800 gallons of advanced treated wastewater was discharged to Salal Creek.
From February 12, 1994 to March 1, 1994 an estimated 900,000 gallons of advanced treated wastewater was discharged to a tributary of the Gualala River and the Gualala River in violation of waste discharge requirements prescribed by the Regional Board.
In June 1995, approximately 584,00 gallons of wastewater was discharged to Salal Creek and the ocean.
In February 1996, there was a discharge of untreated wastewater from the Villa Del Mar Trailer Park in Gualala. It is believed that a good quantity of the discharged waste (8,000 to 10,000 gallons) flowed into China Gulch, into the Gualala River, and out to sea.

Gualala Aggregates, Inc.
Gualala Aggreagates, Inc., operates a sand and gravel plant located adjacent to the South Fork Gualala River west of Annapolis in Section 22, T1ON, R14W, MDB&M. Washwater from the plant is discharged to evaporation/percolation ponds adjacent to the South Fork Gualala River. The Board adopted Order No. 78-135, Waste Discharge Requirements for this facility, on August 24, 1978.

Comments or Issues –
February 1997, a large discharge of fresh concrete had been dumped on a creek bank slope and entered a tributary to Big Gulch Creek. This concrete channel extended from the slide area approximately 250 feet downstream. It was also suspected that this hillside was used for rinsing out the trucks. Remedial actions were to manually break up and remove the concrete from the channel, and revegetate the hillside.

Water Quality Data – historical and current
The water quality analysis included comparison of available data to water quality objectives from the Basin Plan, Total Maximum Daily Load suggested targets, and EMDS dependency relationships (thresholds) and other ranges and thresholds derived from the literature (Table 1). With the exception of the Basin Plan objectives, these ranges and thresholds are not legal regulatory numbers. Rather, they are based on information available at the time and are expected to change as new data and analyses become available.

The D_{50} ranges are based on a study by Knopp (1993) who measured a variety of instream parameters on a number of North Coast streams. He presented results for a group of 18 watersheds judged to have had no human disturbance history or little disturbance within the last 40 years. The mean D_{50} value of this data set was 69 mm. The minimum measured value was 37 mm, and the maximum was 183 mm. The intent in the analyses in this assessment is to evaluate the available data against Knopp's distribution. It is not the intent to suggest 37 mm as a minimum value independent of other information about the distribution of the data.

The temperature range for "fully supportive conditions" of 50-60 F (10-15.6 C) was developed as an average of the needs of several cold water fish species, including coho salmon and steelhead trout. As such, the range does not represent fully supportive conditions for the most sensitive cold water species (usually considered to be coho).

The lethal maximum temperature of 75 F (23.9 C) was derived from literature review presented in RWQCB (2000). Peak temperatures are important to consider as they may reflect short-term thermal extremes that, unless salmonids are able to escape to cool water refugia, may be lethal to fish stocks. The literature supports a critical peak lethal temperature threshold of 75 F (24 C), above which death is usually imminent for many Pacific Coast salmonid species (Brett, 1952; Brungs and Jones, 1977; RWQCB, 2000; Sullivan, et al., 2000).

The data we compared to these ranges and thresholds from a water quality perspective were:

- Continuous water temperature data from data loggers
- Percent fines < 0.85 mm from McNeil samples
- D_{50} from pebble counts
- Dissolved oxygen, pH, conductance (dissolved solids), nutrients (nitrogen, phosphorus)

Turbidity and suspended solids data were not available for this assessment, and represent a limitation in the water quality part of the assessment. The data and summary plots are included in Appendix 9.

Table 1. In-channel criteria used in the assessment of water quality data.

Water Quality Parameter	**Range or Threshold**	**Source of Range or Threshold**
pH	6.5-8.5	Basin Plan, p 3-3.00
Dissolved Oxygen	7.0 mg/L	Basin Plan, p 3-3.00
Temperature	No alteration that affects BUs [1]	Basin Plan, p 3-3.00
	No increase above natural > 5 F	Basin Plan, p 3-4.00
	50-60 F MWAT [2] – proposed fully supportive	EMDS proposed Fully Supportive Range [3]
	75 F daily max (lethal)	Cold water fish rearing, RWQCB (2000), p. 37
Sediment		Basin Plan, p 3-2.00
Settleable matter	Not to cause nuisance or adversely affect BUs	
Suspended load	Not to cause nuisance or adversely affect BUs	Basin Plan, p 3-2.00, 3-3.00
Turbidity	no more than 20 percent increase above natural occurring background levels	Basin Plan, p 3-3.00
Percent fines <0.85 mm	<14% in fish-bearing streams [4]	Gualala TSD, CRWQCB (2001)
Percent fines <6.4 mm	<30% in fish-bearing streams	Gualala TSD, CRWQCB (2001)
V* in 3rd order streams with slopes 1-4 % [5]	$\leq$0.15 (mean) <0.45 (max)	Gualala TSD, CRWQCB (2001)
Median particle size (d_{50}) in 3rd order streams of slopes 1-4 %	>69mm (mean) >37mm (min)	Knopp (1993)

1 BUs = Basin Plan beneficial uses
2 MWAT=maximum average weekly temperature, to be compared to a 7-day moving average of daily average temperature
3 EMDS = Ecological Management Decision Support model used as a tool in the fisheries limiting factors analysis. These ranges and thresholds were derived from the literature and agreed upon by a panel of NCWAP experts.
4 fish-bearing streams=streams with cold water fish species
5 V* is the percentage of residual pool volume occupied by sediment depositions
6 CDFG=Calif. Department of Fish and Game habitat threshold

Basic Water Chemistry

General water quality data were available from:

- StoRet data from USEPA are available for three sites on the Gualala River from: Gualala River near Gualala monthly from February 13, 1975 to April 4, 1985, Wheatfield Fork at the YMCA camp on January 6 and June 3, 1988, and South Fork at Valley Crossing in April and September from 1974 to 1988. All those data indicate a moderatley hard water oligotrophic stream with pH slightly above neutral, high dissolved oxygen, low dissolved solids, and low nutrients (nitrogen and phosphorus). There were no large differences among the stations, though South Fork pH and hardness values were somewhat higher than in the Gualala.
- RWQCB sampling on February 13, May 8, and June 27 at five stations: House Creek, Wheatfield Fork near Valley Crossing, South Fork at Hauser Bridge and near Valley Crossing, and mainstem Gualala River at the Regional Park.All the data indicate a moderately oligotrophic waterbody—low nitrogen and phosphorus levels, moderately buffered, moderately hard water, low heavy metals concentrations, low organic load.

Water Temperature

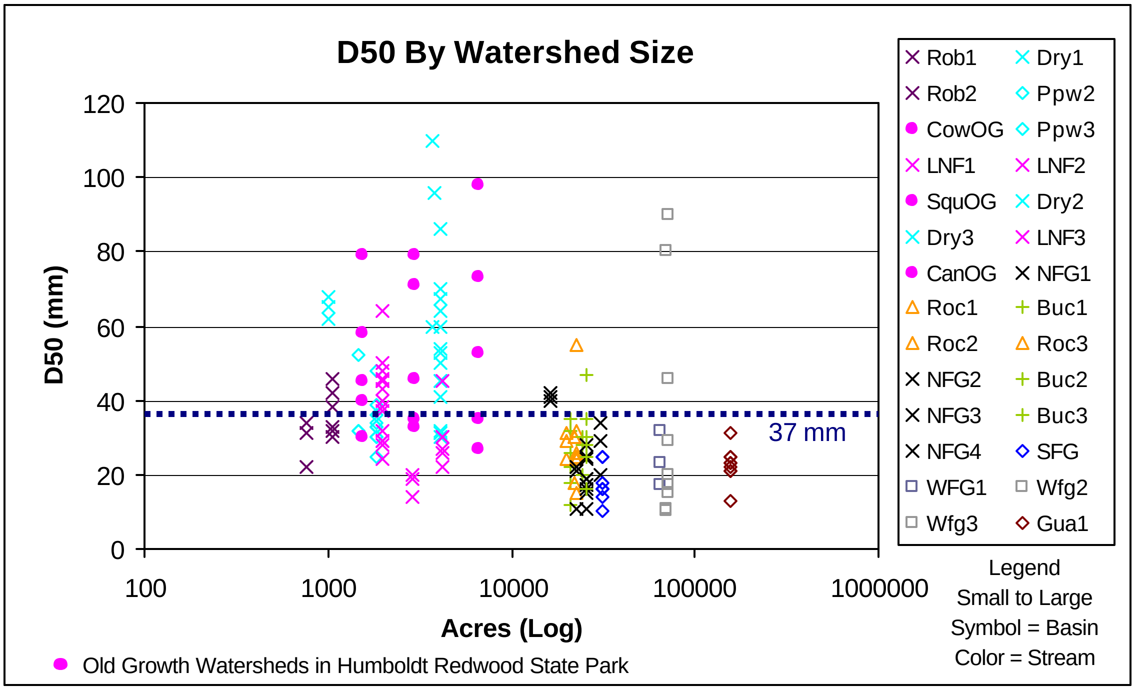
Water temperatures expressed as the highest of the floating weekly average for the summer (MWAT) for the Gualala River watershed overall are normally distributed, but bimodally: about 47% of the values are in the first mode of 57-61 F, and 40% in the second mode of 64-70 F range. There appears to be little temporal trend at any one site, however there are some interesting relationships in some of the sub-watersheds. Most of the sitess are above the proposed "fully supportive" range of 50-60 F (10 to 15.6 C) MWAT, however tributaries in the North Fork basin are generally lower. More relationships on a sub-watershed basis are provided in subsequent sections of this report.

In-Channel Sediment

Streambed core samples are difficult to use in describing conditions on a reach scale, due to variability in the riffles and method. However, the core sample results for the Gualala River watershed are useful in a general sense to provide a coarse idea of conditions, but carry a high level of uncertainty due to small sample sizes (n=8). For those reasons, we cannot say anything definitively regarding percent fine materials in spawning riffles and their distribution throughout the watershed, rather comment regarding specific areas. The Gualala TMDL proposes a target maximum of 14% fines <0.85 mm and less than or equal to 30% fines <6.4 mm.

Pebble counts provide a good measure of the surface composition of the streambed. Trends toward smaller sizes indicate influx of fine sediments and either low stream power or transport capability overwhelmed by small particles (inability to move new sediment through the area). Trends towards larger particles indicate a flushing of smaller particles and sediment transport capability exceeding the influx of new sediment. The Gualala TMDL does not propose a median particle (D_{50})target, however the targets contained in the Garcia TMDL are 37mm as a mimimum and 69mm as a mean in third order streams of 1-4% gradient. For the watershed overall, D50 values ranged from 10-110 mm.

GRI provided the following plot of D50 versus watershed size with the Gualala River data points, as well as for some streams in Humboldt County which contain varying amounts of old growth redwood. Differences in geology, soils, and climate have not been factored into the plot. No relationship of watershed size to D50 was obvious.



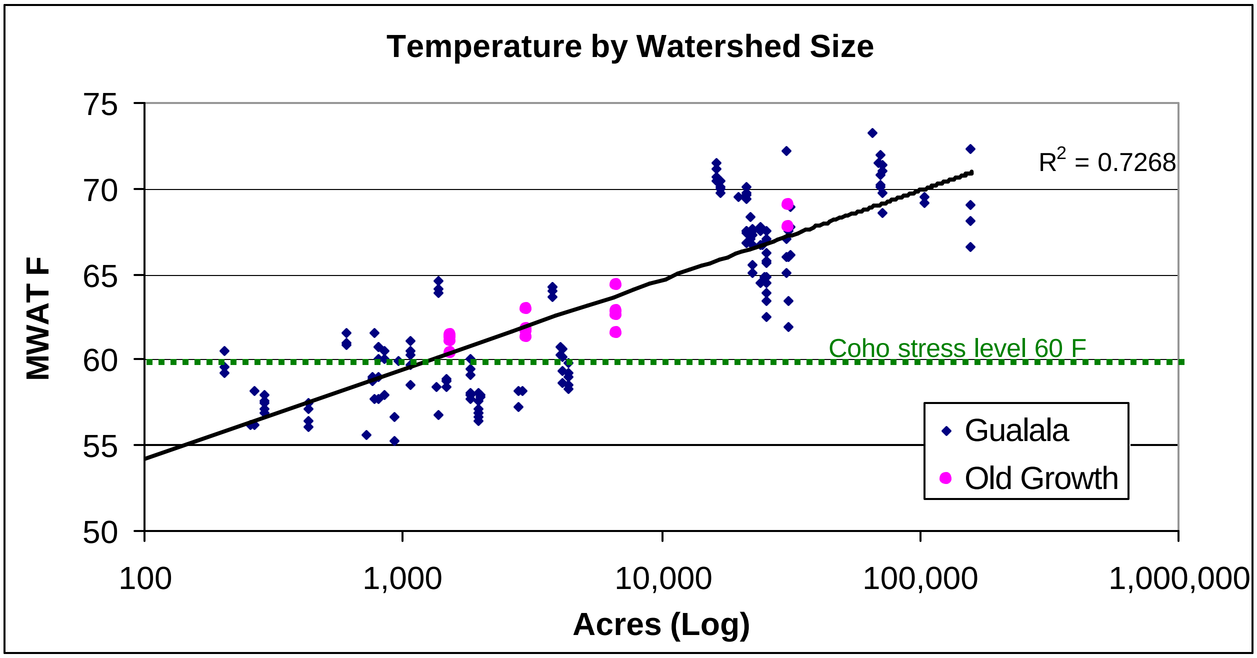
GRI also provided a plot of water temperatures expressed as MWAT for streams in the Gualala River watershed and the same Humboldt County streams as for the D50, above with the following explanatory text:

"Between 1994 and 2000, 154 continuous water temperature records were collected at 54 sites in the Gualala watershed. A trend has emerged indicating that smaller watersheds have lower water temperatures. The Forest Science Project's report in 2000 found a similar trend.

It may be that the larger streams naturally have temperatures above the 60° F Coho stress level. To test this, Gualala temperatures were compared with temperatures collected in old growth watersheds in Humboldt Redwood State Park. The small circles in Figure ___ represent 14 continuous water temperature records collected at 4 sites between 1995 and 1999 by the Pacific Lumber Company. The old growth watersheds, by increasing acreage, are Cow Creek (93% uncut old growth), Squaw Creek (61% uncut old growth) Canoe Creek (62% uncut old growth) and Bull Creek, where the stream flows through 3 miles of uncut old growth, including the Rockefeller Grove, before it gets to the Bull Creek temperature station. The trend line equation for the old growth ($y=2.2886Ln(x)+43.713$) was almost identical to the equation for the Gualala trend line ($y=2.2707Ln(x)+43.683$). The R^2 value for the old growth trend line was 0.8292."

Differences in geology, hydrology, and climate are not accounted for in this plot. However, the relationship of increased temperatures with increased watershed size is evident, as water generally warms as it travels downstream. The ranges for any acreages are fairly high, spanning from about 2 F to 10 F. A normal log scale may be more appropriate, however the general relationship is apparent.

Water Quality staff take issue with the conclusion that higher temperatures in larger streams are natural. While water temperatures generally warm as one moves downstream (larger watershed area), the influences of climate and hydrology add complexity to the relationship, e.g., the situation observed in the Gualala River watershed with higher water temperatures coming off the eastern headwaters areas, then being cooled by tributary inflow, or larger contributions from the groundwater in some areas of a stream. Staff feel the statement is too broad.



The following pages contain the data available for analysis from the various sources.

Water Temperature Data from GRI and GRWC

North Fork Subwatershed MWATs & Maxs in F

Data Source: Gualala Redwoods, Inc.

	MWATs								Maxs							
Site	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
dot256	55								57	64	64	62	63			
dot281					57								59			
dry213		61	61	62						63	63	64				
dry269	60				61				61				64			
dry212		64	64	64	64							69	69			
dry211		60	61	59	61		59	61		64	64	62	63		62	61
lnf255	58								61							
lnf203	56	58	57	58	57	57	57	59	59	60	60	60	59	59	60	59
lnf202	58								62							
lnf201	58	59	58	60	59					62	61	62	61			
lnf274		58	57							62	61					
mcg210		62								69						
mcg209		61	60	58						62	62	60				
nf205		64	64	65						71	69	70				
nf258	67								76							
nf214		70	70	70	71					75	75	75	76			
nf216		71	71	72						79	80	80				
nf204		64	66	65	64		63	64		69	68	67	68		68	68
nf251			62	64				64			66	67				66
nf272	71								76				71			
rob208		59	59	59	59					62	62	62	61			
rob263	60							61	64							
rob207		60	60	61	60		58	61		67	67	68	65		63	63
rob206		58	58	57	58		57			69	62	62	62		64	63
rob260	57								58							
lc215		59	59		61											
dry406					65											

Rockpile Creek MWATs & Maxs in F

Data Source: Gualala Redwoods, Inc.

	MWATs								Maxs							
Site	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
roc221		67	67	67	68		65	65		74	72	72	74		72	71
roc222	67	67	67	68					71	74	72	72				
roc275				67	68							68	75			
roc276				57	57							59	59			
roc401					69								75			

<u>**Water Temperature Data from GRI and GRWC (cont'd)**</u>

Buckeye Creek MWATs & Maxs in F

Data Source: Gualala Redwoods, Inc.

	MWATs								Maxs							
Site	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
buc223		66	66	67		64		64		73	71	72	32	70		70
buc224		68	67	68			65			75	72	73			70	
buc231	67	70	69	70				69	71	76	75	75				76
buc235	65								70							

Wheatfield Fork MWATs & Maxs in F

Data Source: Gualala Redwoods, Inc.

	MWATs						Maxs					
Site	**1995**	**1996**	**1997**	**1998**	**2000**	**2001**	**1995**	**1996**	**1997**	**1998**	**2000**	**2001**
wf226	70	69	71	71			78	75	74	76		
wf227		70	72	71	70			75	78	76	78	
wf228	57	56	58	56			58	57	59	57		
wf273	72				72		80				77	
wf403				73						80		
wf620					73						82	
fc901					66						73	
fc618					66	63					72	70
fc619					66	66					73	75
fc608						64						70
fc606						59						68
wf612						72						79
wf600						70						75

Mainstem and South Fork MWAT & Maxs in F

Data Source: Gualala Redwoods, Inc.

	MWATs								Maxs							
Site	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
lpw220	58	61	59	61	60				60	67	64	62	64			
bpw218	58	59	58	60	59	58	58		61	62	61	63	63	61	61	
bpw219		59	58	59	59					63	62	64	63			
bpw248	59								63							
gh250			56								57					
gh277					56		58							57	64	
sf229		68	66	69						74	72	78				
sf230		66	65	72	67					73	71	76	73			
sf402					68		66						72		72	
gua217	67	69	68	72				72	73	78	76	76				72
gua225		69		69						77		72				
sf616							64	64							66	68
sf227							73	73							73	73
gua614							72	72							73	73
mck615							68	66							70	75
mck617							61	66							61	75
pcc621								73								75

Median particle size data as the mean of 3 transects for the South Fork Gualala/Mainstem Gualala Subbasin. Source=GRI and GRWC, 2001.

Site	Year	D50(mm)
sf402	1997	13
sf402	1999	20
gua217	1998	25
gua217	2000	20
gua225	1998	25
bpw218	1997	31
bpw218	1998	40
bpw218	1999	31
bpw219	1997	39

Median particle size data (mm) as the mean of 3 transects for the Wheatfield Fork Gualala Subbasin. Source=GRI and GRWC, 2001.

Site	1997	2000
wf226	45	30
wf227	34	
wf403	24	

Median particle size data (mm) as the mean of 3 transects for the North Fork Gualala Subbasin. Source=GRI and GRWC, 2001.

Site	1997	1998	1999	2000	2001
dry211	31	45	62	60	64
dry212	89				
dry405	65				
lnf404	26				37
lnf202	18				
lnf203	35	34	46	43	42
nf204	14		20		
nf216	41				
nf406	18				
nf473					28
rob207	38		36		
rob208	29				

Median particle size data (mm) as the mean of 3 transects for the North Fork Gualala Subbasin. Source=CFL, 1997.

Site	1995 - 1997
NGU 1	11
NGU 2	36
NGU 3	25

Range = 11-36 mm; Mean = 24 mm

McNeil core data for percent fines <0.85 mm as the mean of 8 samples for the North Fork Gualala Subbasin. Source=GRI and GRWC, 2001.

Site	1992	1993	1994	1995	1996	1997
dot256		16	11	17	17	17
dry211			17	16	15	12
lnf255		19		12	24	28
lnf201	11	21	20	21	15	16
lnf202		12	13	18	18	22
lnf203		17	20	11	20	19
mcg209				19	27	20
rob207				15	18	18

Median particle size data (mm) as the mean of 3 transects for the Buckeye Creek Subbasin. Source=GRI and GRWC, 2001.

Site	1997	1998	2000
buc223	25		37
buc224	26		
buc231	24	24	

Median particle size data (mm) as the mean of 3 transects for the Rockpile Creek Subbasin. Source=GRI and GRWC, 2001.

Site	1997	1998	1999
roc221	27	25	32
roc275	26		
roc401	28		

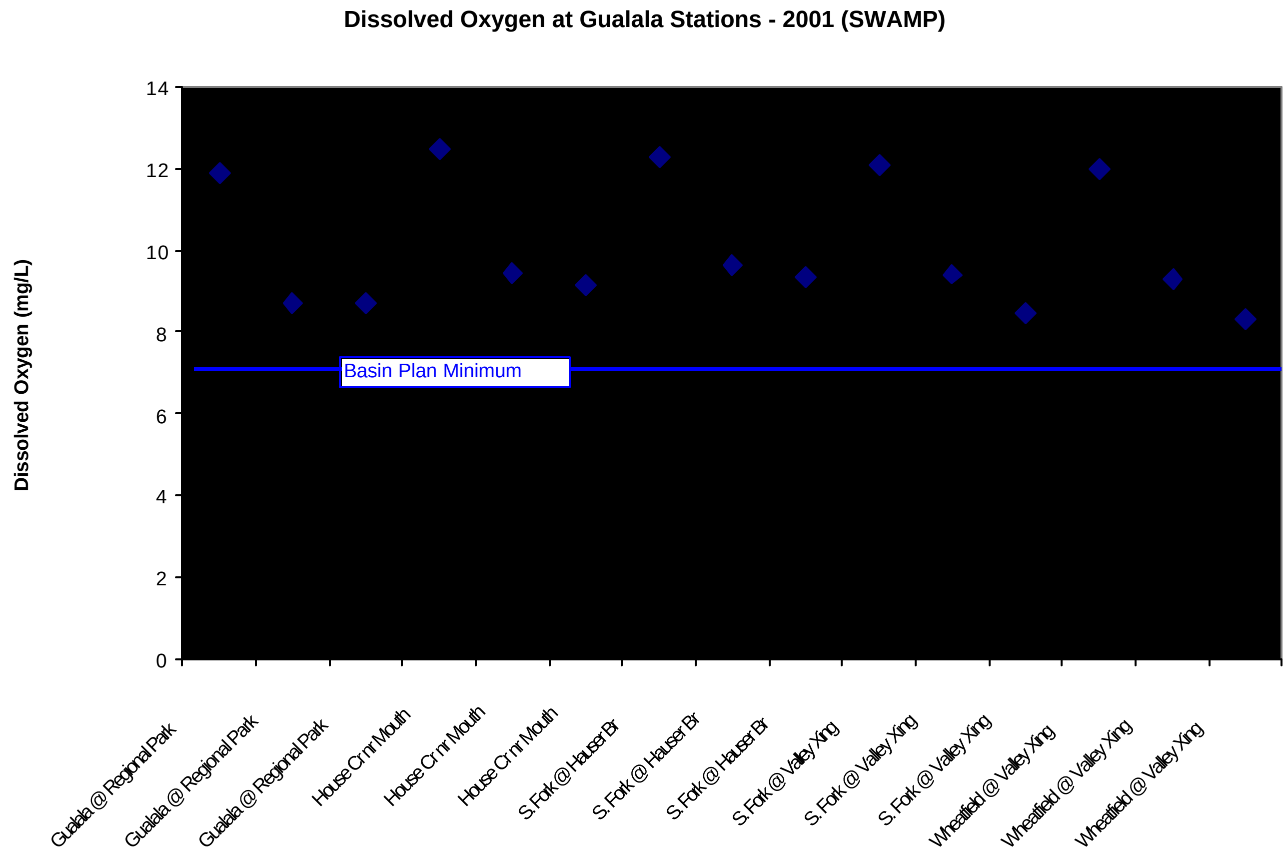
Surface Water Ambient Monitoring Data (SWAMP) from year 2001 sampling.

Sample Location	Date	Time	Diss. Oxygen mg/L	pH	Specific Cond. umho/ cm	Water Temp (C)	Air Temp (C)	Turb (FTU)	Total Alk mg/L	Ammonia-N mg/L	Nitrate-N mg/L	Kjeldahl-N mg/L
Gualala @ Regional Park	2/13/01	1515	11.9	7.22	156	7.7	15	20				
Gualala @ Regional Park	5/8/01	1320	8.7	6.78	235	18.6	18		86	<0.050	<0.050	<0.50
Gualala @ Regional Park	6/27/01	1455	8.7	7.72	193	16.1	14.5	0.87	78	<0.050	<0.050	<0.50
House Cr nr Mouth	2/13/01	1142	12.5	7.93	170	6.6	14	11				
House Cr nr Mouth	5/8/01	1135	9.45	7.75	321	21.1	27		152	<0.050	<0.050	<0.50
House Cr nr Mouth	6/27/01	1250	9.15	8.56	256	18	16	0.6	130	<0.050	<0.050	<0.50
S. Fork @ Hauser Br	2/13/01	1005	12.3	7.54	122	5.7	7.5	14				
S. Fork @ Hauser Br	5/8/01	1030	9.65	7.03	212	15.7	24.5		98	<0.050	<0.050	<0.50
S. Fork @ Hauser Br	6/27/01	1200	9.34	8.18	202	16.7	15.5	1.7	82	<0.050	<0.050	<0.50
S. Fork @ Valley Xing	2/13/01	1415	12.1	7.26	135	6.9	18.5	15				
S. Fork @ Valley Xing	5/8/01	1255	9.42	6.87	235	18.8	19.5		88	<0.050	<0.050	<0.50
S. Fork @ Valley Xing	6/27/01	1415	8.48	7.88	259	16.9	14.5	0.68	100	0.24	<0.050	<0.50
Wheatfield @ Valley Xing	2/13/01	1355	12	7.32	147	7.9	19	17				
Wheatfield @ Valley Xing	5/8/01	1235	9.28	6.9	252	18.5	22		112	<0.050	<0.050	<0.50
Wheatfield @ Valley Xing	6/27/01	1345	8.3	7.84	244	17.5	15	0.18	100	<0.050	<0.050	<0.50

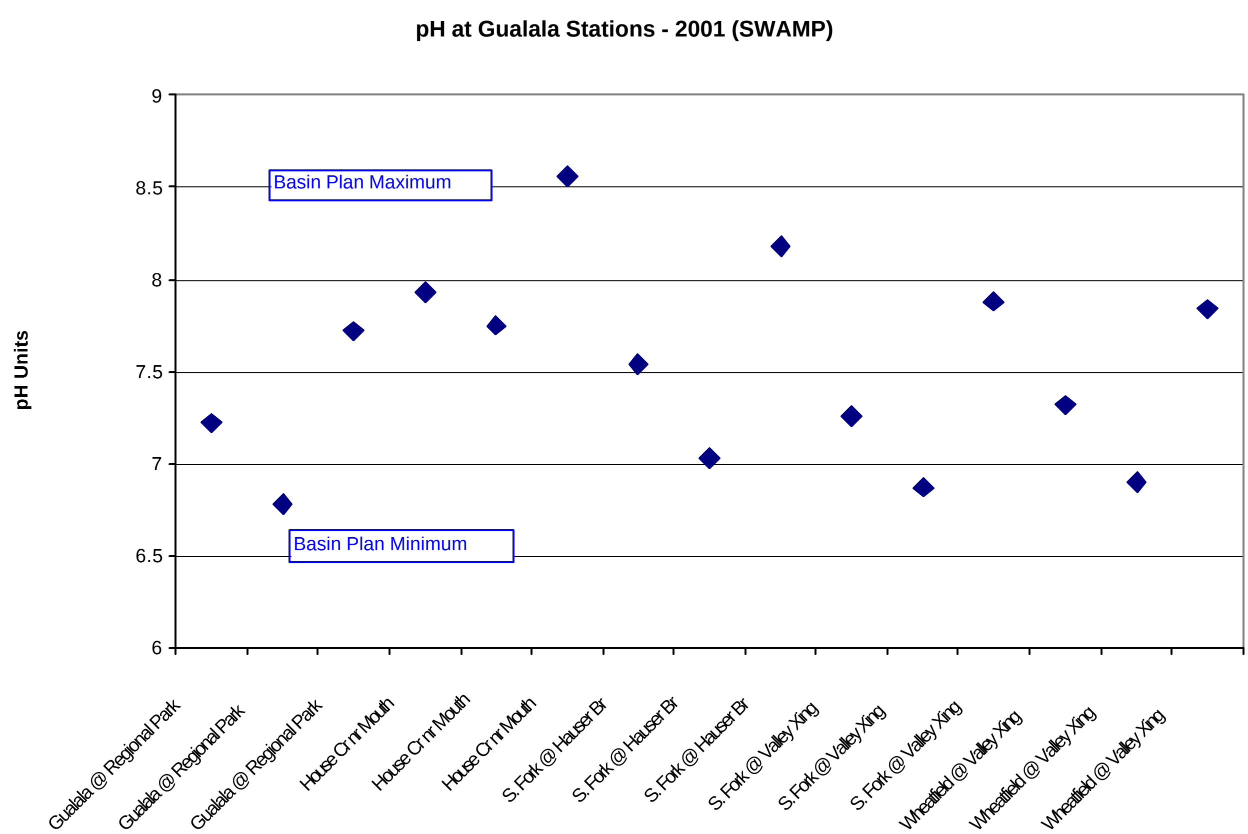
Surface Water Ambient Monitoring Data (SWAMP) from year 2001 sampling (cont'd).

Sample Location	Date	Time	Ortho-phosphate-P mg/L	Chl-a mg/L	Hardness mg/L	Heavy Metals *	Minerals
Gualala @ Regional Park	2/13/01	1515					
Gualala @ Regional Park	5/8/01	1320	<0.050		92.9	ND	minerals will be reported
Gualala @ Regional Park	6/27/01	1455	<0.050	<0.00050	68	ND	in a later draft
House Cr nr Mouth	2/13/01	1142					
House Cr nr Mouth	5/8/01	1135	<0.050		158	ND	
House Cr nr Mouth	6/27/01	1250	<0.050	0.0014	130	ND	
S. Fork @ Hauser Br	2/13/01	1005					
S. Fork @ Hauser Br	5/8/01	1030	<0.050		83.7	ND	
S. Fork @ Hauser Br	6/27/01	1200	<0.050	<0.00050	84	ND	
S. Fork @ Valley Xing	2/13/01	1415					
S. Fork @ Valley Xing	5/8/01	1255	<0.050		99.8	ND	
S. Fork @ Valley Xing	6/27/01	1415	<0.050	<0.00050	110	ND	
Wheatfield @ Valley Xing	2/13/01	1355					
Wheatfield @ Valley Xing	5/8/01	1235	<0.050		101	ND	
Wheatfield @ Valley Xing	6/27/01	1345	<0.050	0.0013	99	ND	

* Metals = cadmium, chromium, copper, lead, nickel, zinc, mercury at reporting levels of 10, 10, 10, 75, 30, 20, 0.200 ug/L, respectively

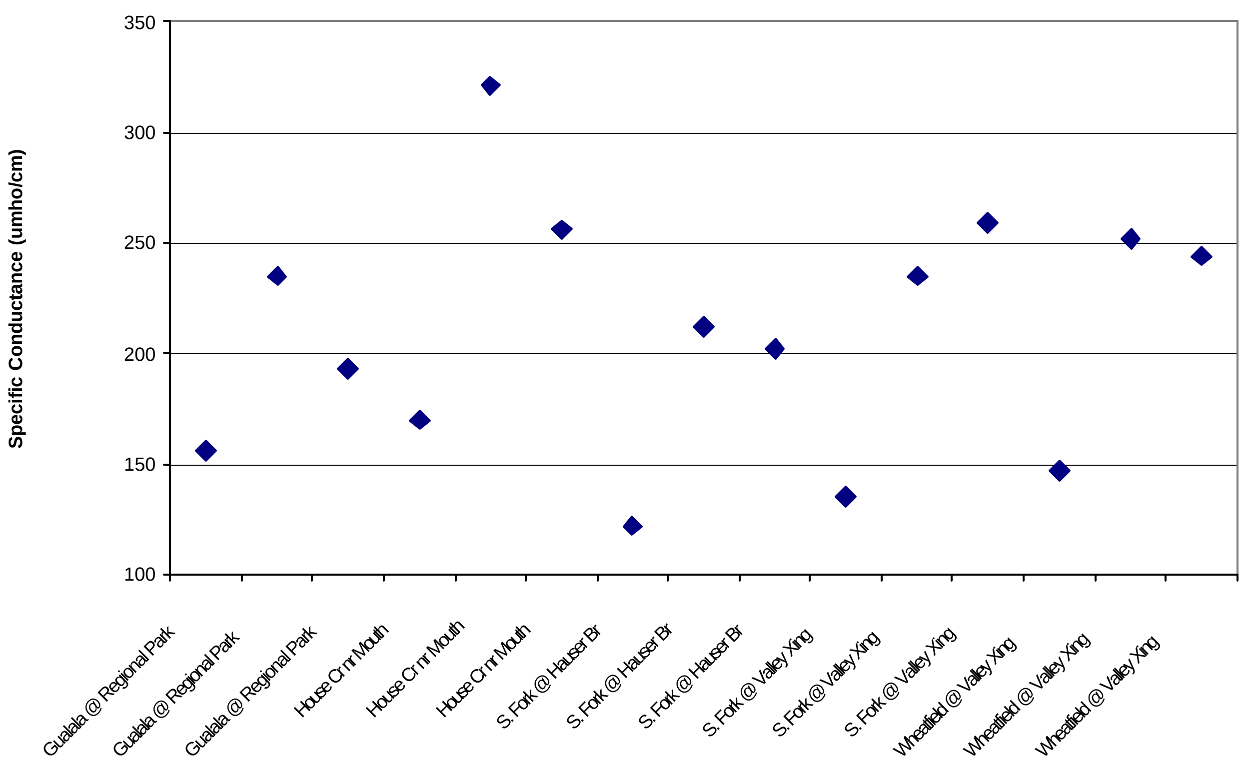


Dissolved Oxygen at Gualala Stations - 2001 (SWAMP)
Dissolved Oxygen (mg/L)
14
12
10
8
6
4
2
0
Basin Plan Minimum
Gualala @ Regional Park
Gualala @ Regional Park
Gualala @ Regional Park
House Cr nr Mouth
House Cr nr Mouth
House Cr nr Mouth
S.Fork @ Hauser Br
S.Fork @ Hauser Br
S.Fork @ Hauser Br
S.Fork @ Valley Xing
S. Fork @ Valley Xing
S. Fork @ Valley Xing
Wheatfield @ Valley Xing
Wheatfield @ Valley Xing
Wheatfield @ Valley Xing

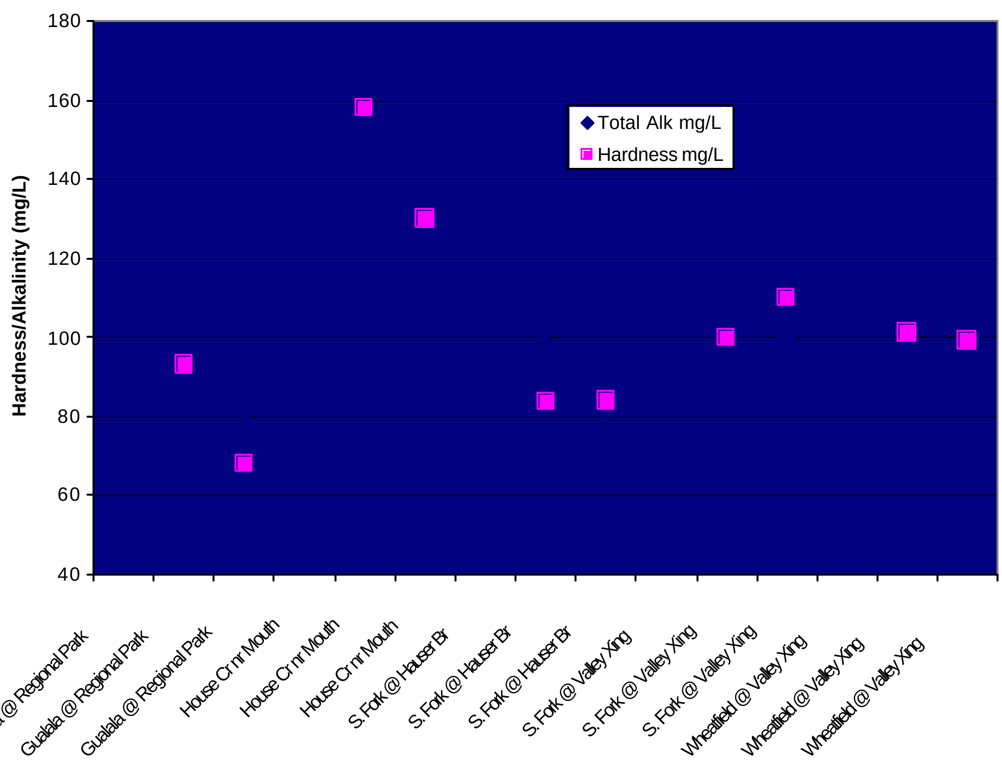


pH at Gualala Stations - 2001 (SWAMP)
pH Units
9
8.5
8
7.5
7
6.5
6
Basin Plan Maximum
Basin Plan Minimum
Gualala @ Regional Park
Gualala @ Regional Park
Gualala @ Regional Park
House Cr nr Mouth
House Cr nr Mouth
House Cr nr Mouth
S. Fork @ Hauser Br
S. Fork @ Hauser Br
S. Fork @ Hauser Br
S. Fork @ Valley Xing
S. Fork @ Valley Xing
S. Fork @ Valley Xing
Wheatfield @ Valley Xing
Wheatfield @ Valley Xing
Wheatfield @ Valley Xing

Specific Conductance at Gualala Stations - 2000 (SWAMP)



Alkalinity and Hardness at Gualala Stations - 2000 (SWAMP)



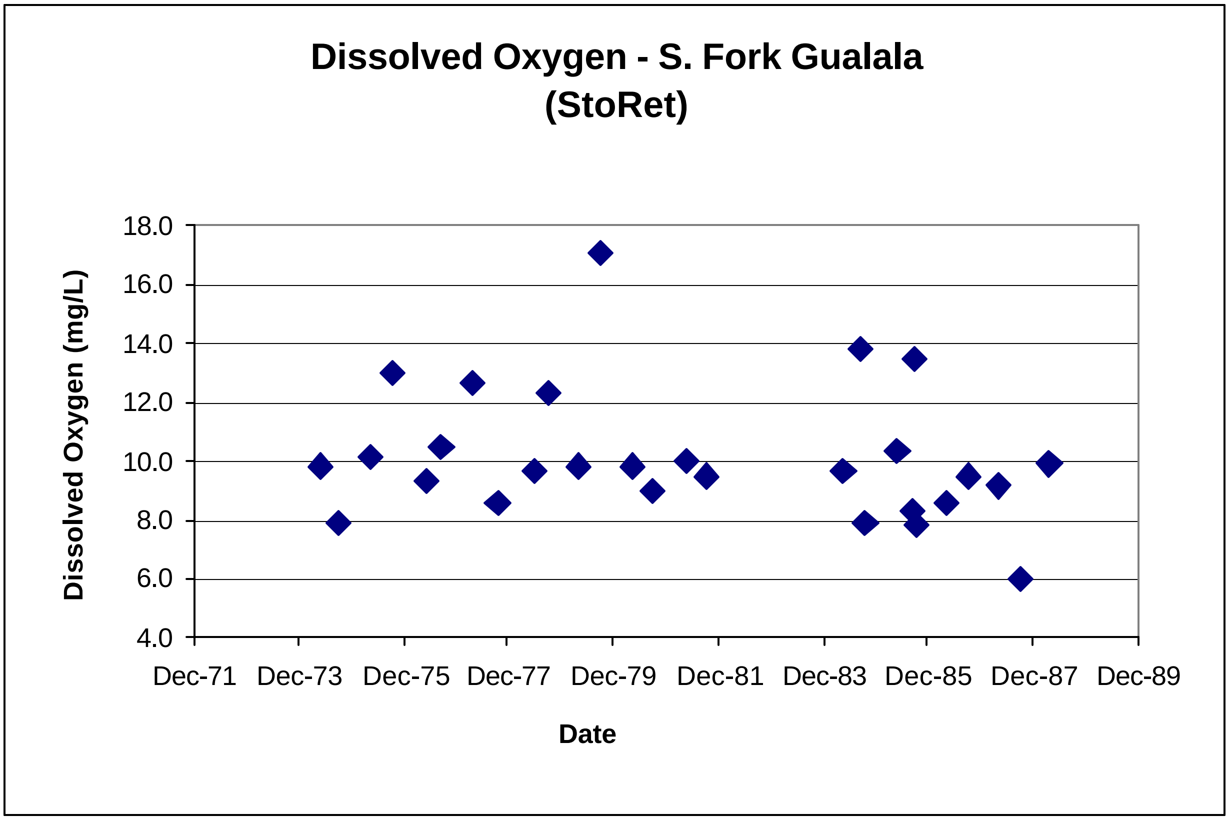
StoRet Data for the South Fork Gualala River near Valley Crossing

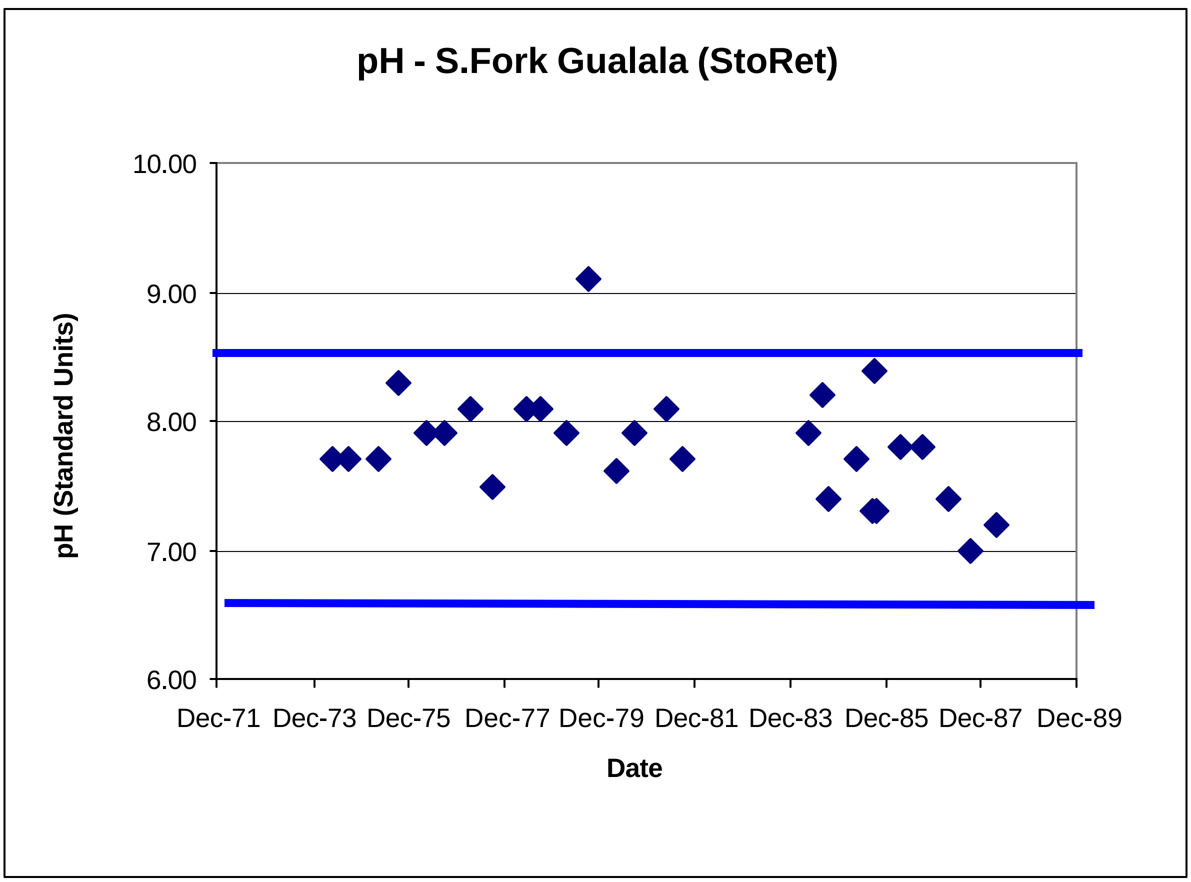
GUALALA R S F NR ANNAPOLIS, CA WATER RES CNTRL BD, F8110000,38.702778 LAT, 123.416667 LONG, HUC 18010109

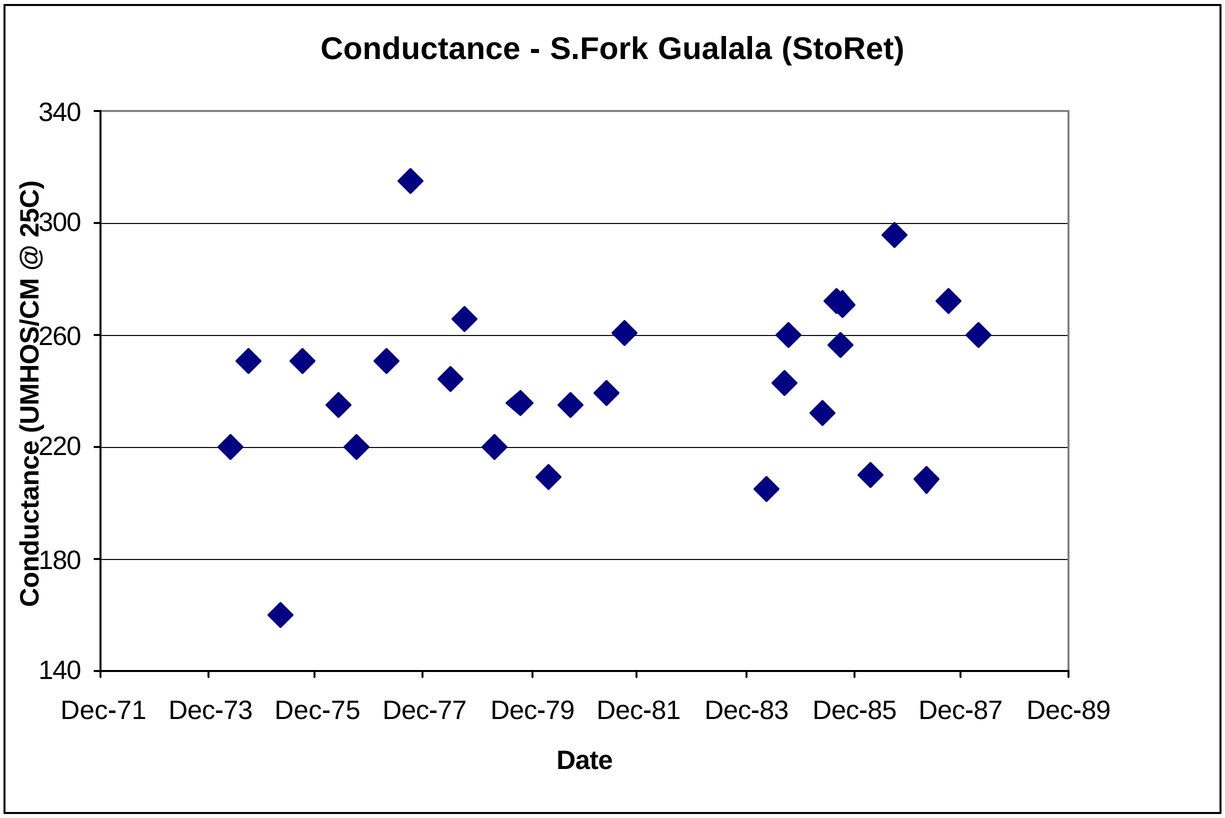
START DATE	START TIME	WATER TEMP (C)	WATER TEMP (F)	FIELD SPECIFIC CONDUCTANCE (UMHOS/CM @ 25C)	TURBIDITY, HACH TURBIDIMETER (FORMAZIN TURB UNIT)	DISS OXYGEN (MG/L)	DISS OXYGEN (% SAT)	PH (STANDARD UNITS)
21-May-74	1550	18.3	65	220	1	9.8	103.34	7.7
11-Sep-74	1330	20.6	69	250	1	7.9	87.94	7.7
24-Apr-75	1530	11.7	53	160	90	10.2	94.61	7.7
18-Sep-75	1600	20.0	68	250	0	13.0	141.56	8.3
14-May-76	1000	17.8	64	235	0	9.3	98.07	7.9
3-Sep-76	1030	19.4	67	220	0	10.5	111.90	7.9
12-Apr-77	1230	17.8	64	250	0	12.7	133.93	8.1
21-Sep-77	1430	20.6	69	315	0	8.6	95.73	7.5
9-Jun-78	1545	22.8	73	244	0	9.7	111.70	8.1
21-Sep-78	1415	20.6	69	266		12.3	136.91	8.1
18-Apr-79	1545	15.6	60	220		9.8	98.18	7.9
19-Sep-79	1400	24.4	76	236	0	17.1	201.54	9.1
16-Apr-80	1415	17.2	63	209		9.8	101.21	7.6
4-Sep-80	1115	18.3	65	235		9.0	94.91	7.9
6-May-81	1350	18.3	65	239		10.0	105.45	8.1
16-Sep-81	1445	22.2	72	261		9.5	108.15	7.7
3-May-84	1215	15.6	60	205		9.7	97.17	7.9
23-Aug-84	1740	22.2	72	243		13.8	157.10	8.2
25-Sep-84	1210	17.2	63	260		7.9	81.59	7.4
8-May-85	1345	17.8	64	232		10.3	108.62	7.7
27-Aug-85	1045	19.0		272	1	8.3	88.46	7.3
12-Sep-85	1345	20.6	69	256	2	13.5	150.27	8.4
26-Sep-85	1045	17.2		271	1	7.8	80.56	7.3
10-Apr-86	1030	14.7		210	1	8.6	84.47	7.8
11-Sep-86	840	17.5		296	1	9.5	98.11	7.8
14-Apr-87	1300	15.5		208		9.2	90.36	7.4
10-Sep-87	845	17.9		272		6.0	63.27	7.0
6-Apr-88	1500	15.8		260		9.9	99.18	7.2

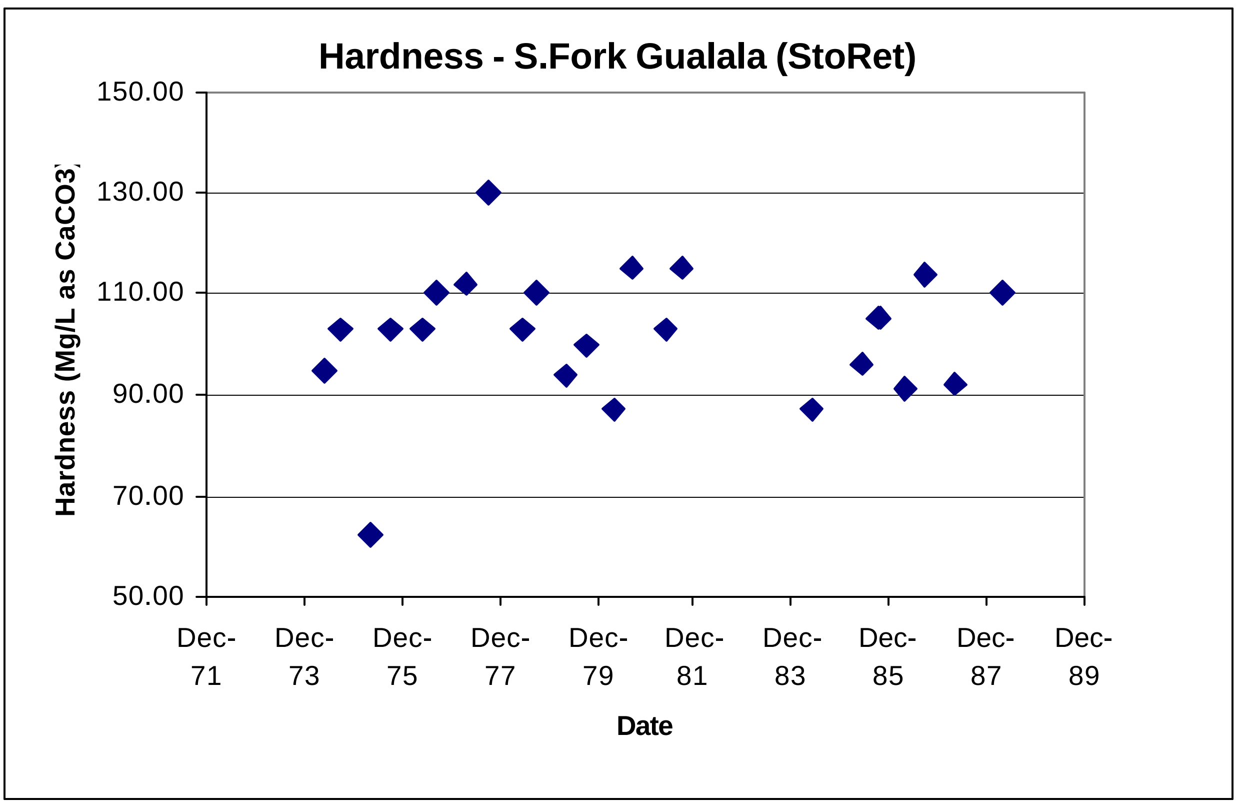
StoRet Data for the South Fork Gualala River near Valley Crossing (cont'd.)

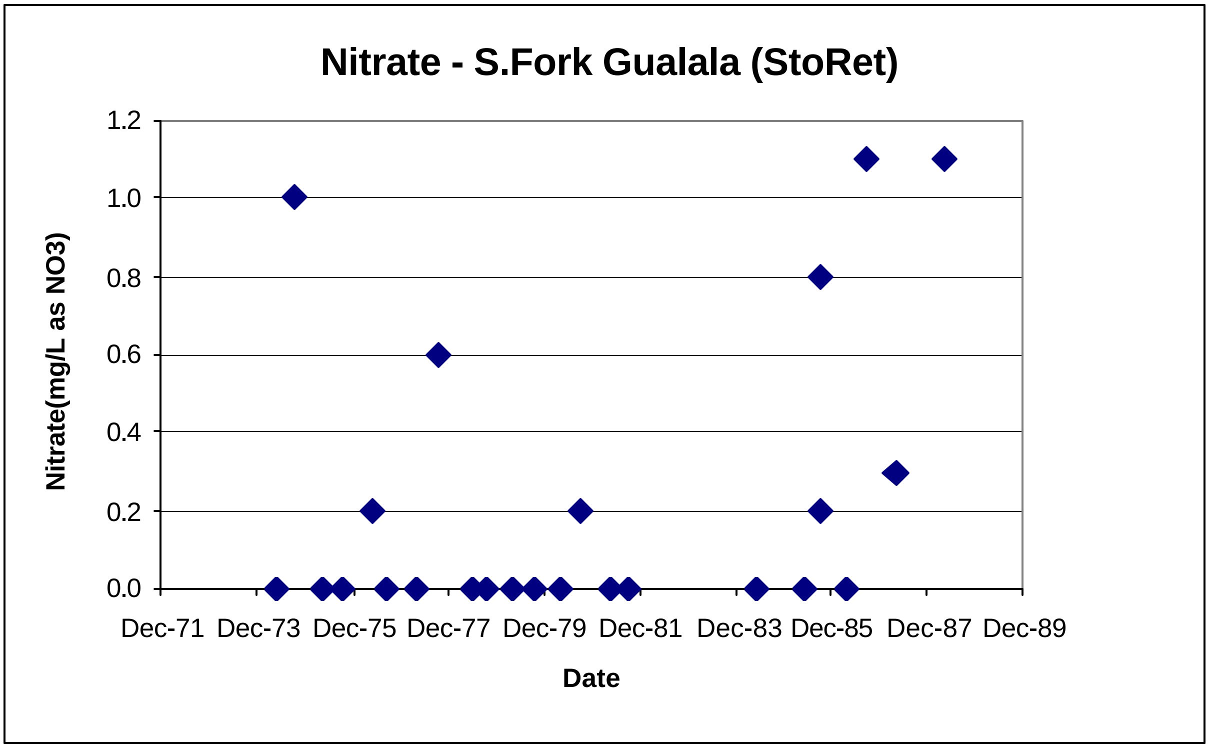
START DATE	START TIME	TOTAL ALKALINITY (MG/L AS CACO3)	ALKALINITY, FILTERED SAMPLE (AS CACO3 MG/L)	TOTAL HARDNESS (MG/L AS CACO3)	DISS NITRATE NITROGEN (MG/L AS NO3)	PHOSPHORUS, TOTAL ORTHOPHOSPHATE (MG/L AS P)	METALS
21-May-74	1550	94		95	0.0		All Nondetect
11-Sep-74	1330	108		103	1.0		
24-Apr-75	1530	61		62	0.0		
18-Sep-75	1600	109		103	0.0		
14-May-76	1000	105		103	0.2		
3-Sep-76	1030	114		110	0.0		
12-Apr-77	1230	109		112	0.0		
21-Sep-77	1430	129		130	0.6		
9-Jun-78	1545	100		103	0.0		
21-Sep-78	1415	113		110	0.0		
18-Apr-79	1545			94	0.0		
19-Sep-79	1400			100	0.0		
16-Apr-80	1415			87	0.0		
4-Sep-80	1115		112	115	0.2		
6-May-81	1350		103	103	0.0		
16-Sep-81	1445		114	115	0.0		
3-May-84	1215		86	87	0.0		
23-Aug-84	1740					0.04	
8-May-85	1345		100	96	0.0		
27-Aug-85	1045					0.01	
12-Sep-85	1345		111	105	0.2		
26-Sep-85	1045		109	105	0.8		
10-Apr-86	1030		92	91	0.0	0.02	
11-Sep-86	840		117	114	1.1	0.01	
14-Apr-87	1300		89	92	0.3	0.01	
10-Sep-87	845						
6-Apr-88	1500		101	110	1.1		All Nondetect

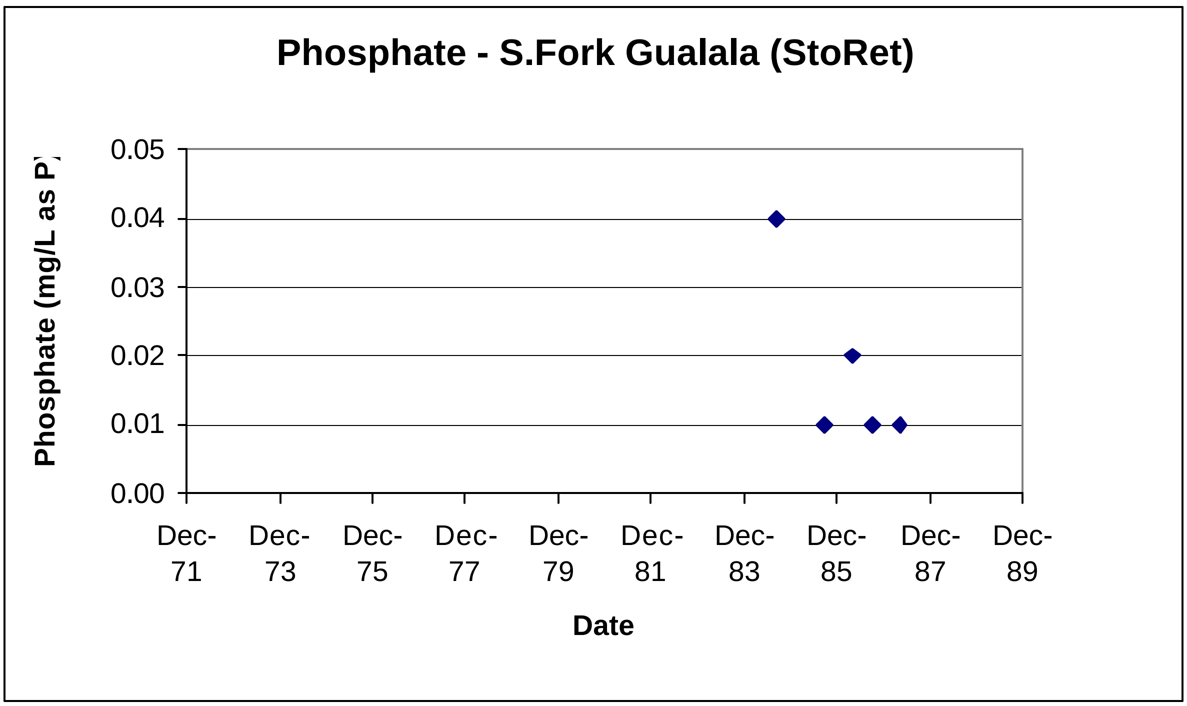

Dissolved Oxygen - S. Fork Gualala
(StoRet)
Dissolved Oxygen (mg/L)
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
Dec-71 Dec-73 Dec-75 Dec-77 Dec-79 Dec-81 Dec-83 Dec-85 Dec-87 Dec-89
Date


pH - S.Fork Gualala (StoRet)
pH (Standard Units)
10.00
9.00
8.00
7.00
6.00
Dec-71 Dec-73 Dec-75 Dec-77 Dec-79 Dec-81 Dec-83 Dec-85 Dec-87 Dec-89
Date


Conductance - S.Fork Gualala (StoRet)
340
300
260
220
180
140
Conductance (UMHOS/CM @ 25C)
Dec-71
Dec-73
Dec-75
Dec-77
Dec-79
Dec-81
Dec-83
Dec-85
Dec-87
Dec-89
Date


Hardness - S.Fork Gualala (StoRet)
150.00
130.00
110.00
90.00
70.00
50.00
Hardness (Mg/L as CaCO3)
Dec-71
Dec-73
Dec-75
Dec-77
Dec-79
Dec-81
Dec-83
Dec-85
Dec-87
Dec-89
Date


Nitrate - S.Fork Gualala (StoRet)
Nitrate(mg/L as NO3)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Dec-71 Dec-73 Dec-75 Dec-77 Dec-79 Dec-81 Dec-83 Dec-85 Dec-87 Dec-89
Date


Phosphate - S.Fork Gualala (StoRet)
Phosphate (mg/L as P)
0.05
0.04
0.03
0.02
0.01
0.00
Dec-71 Dec-73 Dec-75 Dec-77 Dec-79 Dec-81 Dec-83 Dec-85 Dec-87 Dec-89
Date

StoRet Data for the Wheatfield Fork Gualala River near Valley Crossing

WHEATFIELD FK GUALALA R @ BERK YMCA CAMP CA WATER RES CNTRL BD WB01B138401000138.669444 LAT 123.298611 LONG
HUC 18010109

START DATE	START TIME	WATER TEMP (C)	TURBIDITY ,LAB (NTU)	SPECIFIC CONDUCTANCE (UMHOS/CM @ 25C)	PH, LAB (STANDARD UNITS)	TOTAL ALKALINITY (MG/L AS CACO3)	TOTAL NITRATE NITROGEN (MG/L AS N)	TOTAL NITRITE NITROGEN (MG/L AS N)
6-Jan-88	1300	10	36.0	140	8.00	80	0.04	<0.03
3-Jun-88	1400	22	1.6	320	8.30	140	0.05	<0.03

START DATE	START TIME	TOTAL HARDNESS (MG/L AS CACO3)	PHOSPHORUS, TOTAL ORTHOPHOSPHATE (MG/L AS P)	DISS OXYGEN (MG/L)	DISS OXYGEN (% SAT)	AMMONIA, UNIONZED (MG/L AS N)	METALS
6-Jan-88	1300	62.00	0.02	12.60	112	0.00	All Nondetect
3-Jun-88	1400	120.00	0.05	8.70	99	0.00	All Nondetect

StoRet Data for the Mainstem Gualala River near Gualala

GUALALA R NR GUALALA CA WATER RES CNTRL BD F810070038.775556 LAT 123.498611 LONG
HUC 18010109

START DATE	START TIME	AIR TEMP (C)	WATER TEMP (F)	DISS NITRATE NITROGEN (MG/L AS N)	FIELD SPECIFIC CONDUCTANCE (UMHOS/CM @ 25C)	TURBIDITY,HACH TURBIDIMETER (FORMAZIN TURB UNIT)
13-Feb-75	2500			0.50	87	500
14-Sep-76	1040	18.3	65	0.03	220	
14-Sep-76	1815	18.3			216	1
14-Sep-76	2130	17.0			218	1
15-Sep-76	500	15.0			218	1
15-Sep-76	820	15.0			218	
15-Sep-76	1100	17.8			218	
30-Nov-76	1430	11.1			230	3
1-Dec-76	930	7.8	46	0.00	230	0
1-Dec-76	1705	11.0			220	1
1-Dec-76	2045	9.5			244	2
2-Dec-76	545	8.0			232	1
2-Dec-76	900	9.0				1
2-Dec-76	1200	9.5				1
8-Mar-77	1600	15.6			240	
9-Mar-77	1530	13.0		0.04	225	0
9-Mar-77	1800	12.8			233	1
9-Mar-77	2100	11.7			235	1
10-Mar-77	530	8.9			232	1
10-Mar-77	1000	10.0			240	1
17-Mar-77	1130	11.8			210	5
24-May-77	1315	20.0			250	
25-May-77	830	14.4			245	
25-May-77	1740	17.2	63	0.26	245	0
25-May-77	1900	15.0			215	
26-May-77	945	15.6			235	
27-May-77	700	13.3			240	
13-Oct-77	1620	16.7	62	0.00	240	
14-Oct-77	520	12.8			240	
14-Oct-77	830	12.8			240	
4-Apr-85	1235	16.7	62		176	3

StoRet Data for the Mainstem Gualala River near Gualala (cont'd.)

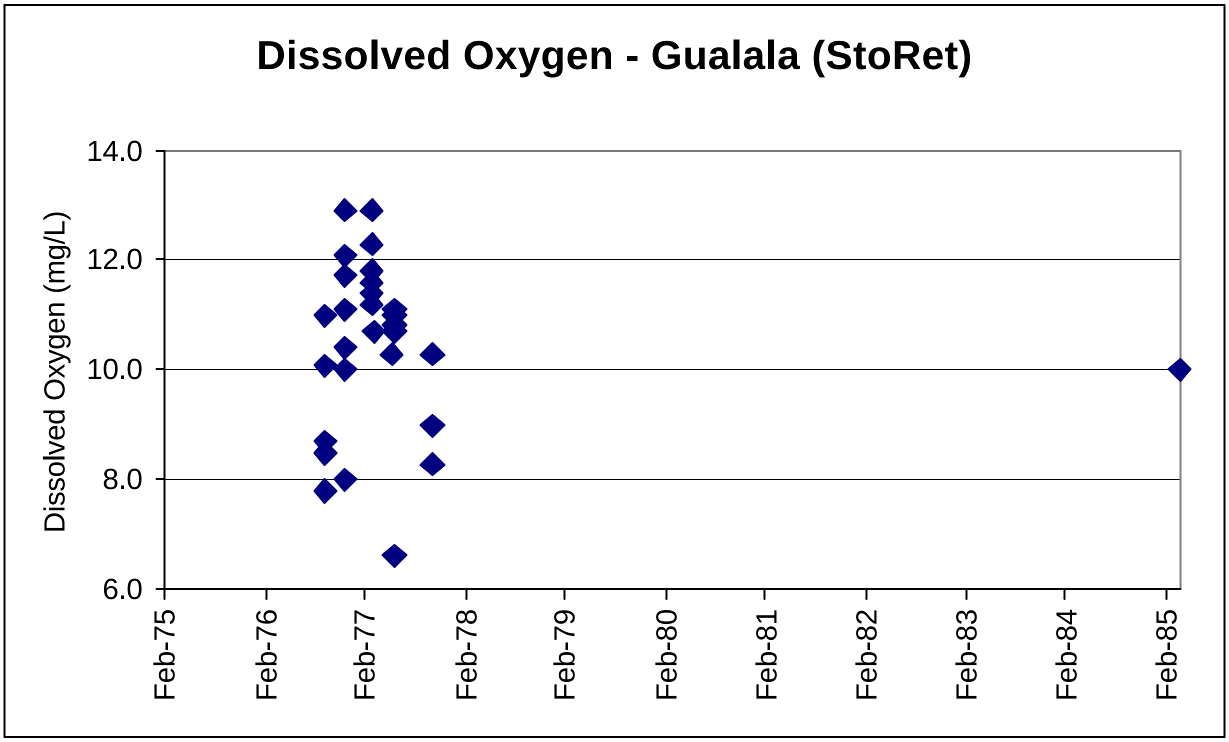
START DATE	START TIME	DISS OXYGEN (MG/L)	DISS OXYGEN (% SAT)	PH (STANDARD UNITS)	PH, LAB (STANDARD UNITS)	SPECIFIC CONDUCTANCE (UMHOS/CM @ 25C)
13-Feb-75	2500				7.4	
14-Sep-76	1040	11.0	116.04		8.2	210
14-Sep-76	1815	8.5	89.67		7.3	214
14-Sep-76	2130	8.5	87.82		7.5	218
15-Sep-76	500	7.8	76.64		7.4	218
15-Sep-76	820	8.7	85.48		7.4	
15-Sep-76	1100	10.1	106.55		7.3	
30-Nov-76	1430	12.9	116.47		7.6	232
1-Dec-76	930	11.7	98.53		8.0	227
1-Dec-76	1705	8.0	72.23		7.4	244
1-Dec-76	2045	10.0	86.39		7.5	
2-Dec-76	545	10.4	87.58		7.6	
2-Dec-76	900	11.1	95.90		7.5	232
2-Dec-76	1200	12.1	104.54		7.5	230
8-Mar-77	1600	11.8	118.26		8.1	
9-Mar-77	1530	12.9	121.96		8.1	226
9-Mar-77	1800	11.4	107.78		7.8	233
9-Mar-77	2100	11.6	107.64		8.0	
10-Mar-77	530	11.2	96.76		7.7	224
10-Mar-77	1000	12.3	109.09		7.7	234
17-Mar-77	1130	10.7	99.29	7.5	7.7	215
24-May-77	1315	10.3	112.20	7.4		
25-May-77	830	10.8	104.07	7.4		
25-May-77	1740	11.1	114.68	7.6	8.1	235
25-May-77	1900	6.6	64.85	7.0		
26-May-77	945	11.0	110.24	7.6		
27-May-77	700	10.7	101.16			
13-Oct-77	1620	10.3	106.42	7.4	8.3	188
14-Oct-77	520	8.3	78.47	7.3		
14-Oct-77	830	9.0	85.09	7.3		
4-Apr-85	1235	10.0	103.32	7.4		

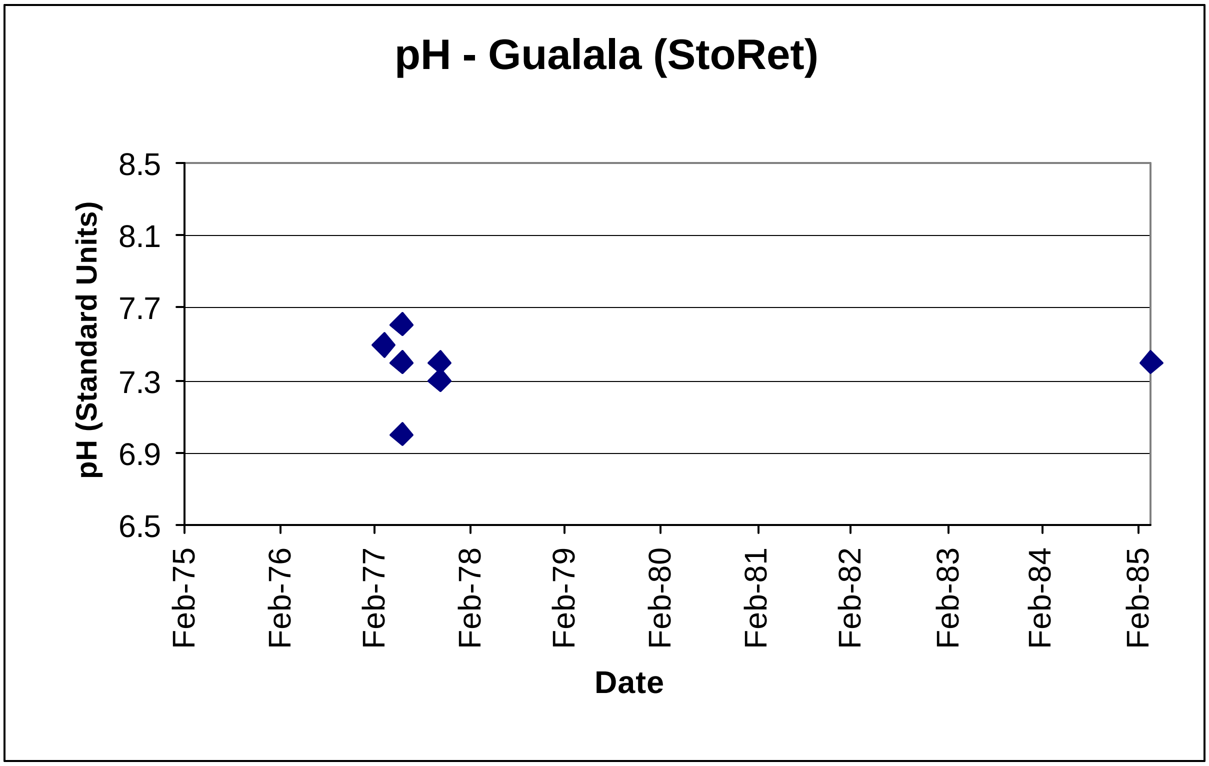
StoRet Data for the Mainstem Gualala River near Gualala (cont'd.)

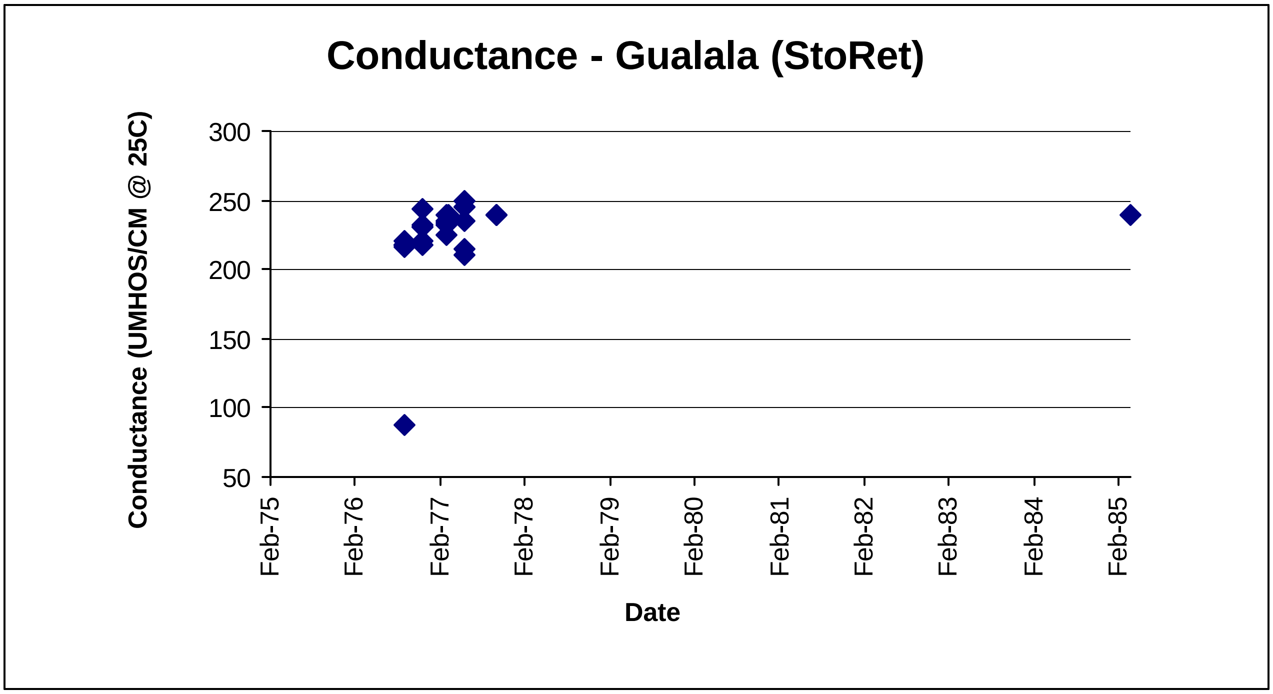
START DATE	START TIME	TOTAL ALKALINITY (MG/L AS CACO3)	DISS NITRATE NITROGEN (MG/L AS NO3)	UNIONIZED AMMONIA (MG/L)	TOTAL NITROGEN, AMMONIA (MG/L AS N)	TOTAL HARDNESS (MG/L AS CACO3)
13-Feb-75	2500		0.50			33.86
14-Sep-76	1040	94	0.03	0.00	0.01	87.00
14-Sep-76	1815					
14-Sep-76	2130					
15-Sep-76	500					
15-Sep-76	820					
15-Sep-76	1100					
30-Nov-76	1430					
1-Dec-76	930	98	0.00	0.00	0.00	91.00
1-Dec-76	1705					
1-Dec-76	2045					
2-Dec-76	545					
2-Dec-76	900					
2-Dec-76	1200					
8-Mar-77	1600					
9-Mar-77	1530	94	0.04	0.00	0.00	92.00
9-Mar-77	1800					
9-Mar-77	2100					
10-Mar-77	530					
10-Mar-77	1000					
17-Mar-77	1130					
24-May-77	1315					
25-May-77	830					
25-May-77	1740	99	0.26	0.00	0.00	92.82
25-May-77	1900					
26-May-77	945					
27-May-77	700					
13-Oct-77	1620	78	0.00	0.00	0.00	77.00
14-Oct-77	520					
14-Oct-77	830					
4-Apr-85	1235					

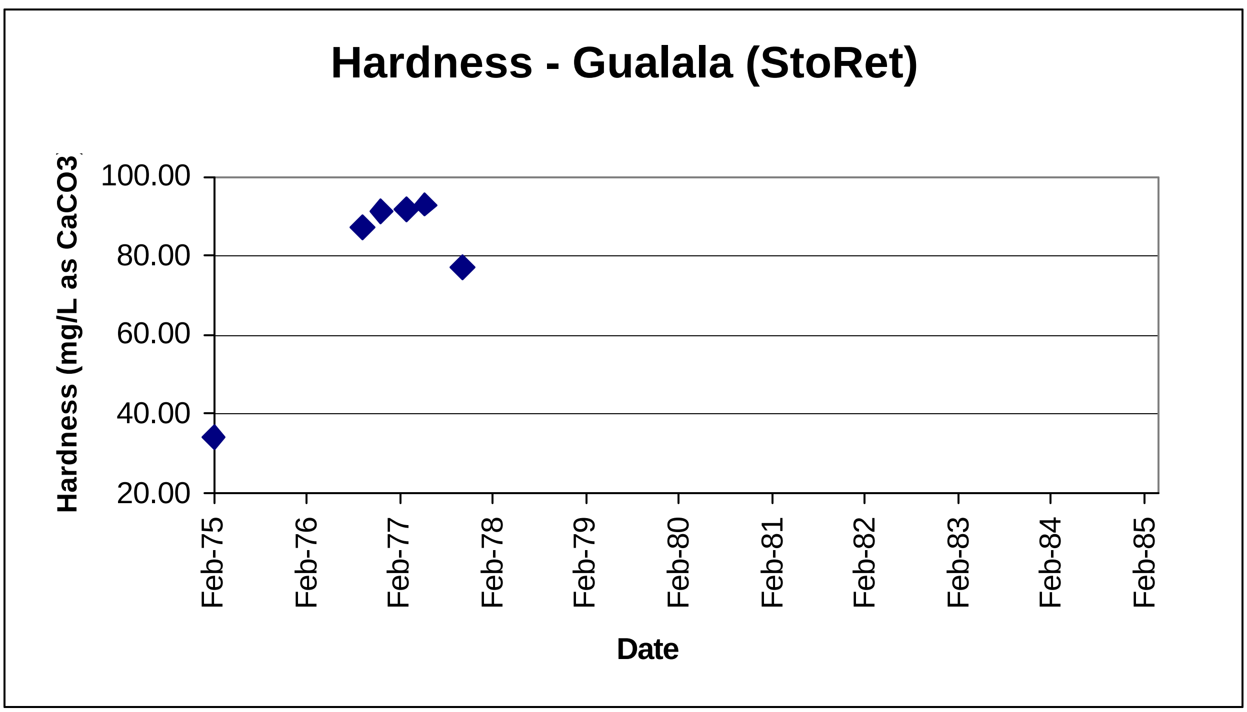
StoRet Data for the Mainstem Gualala River near Gualala (cont'd.)

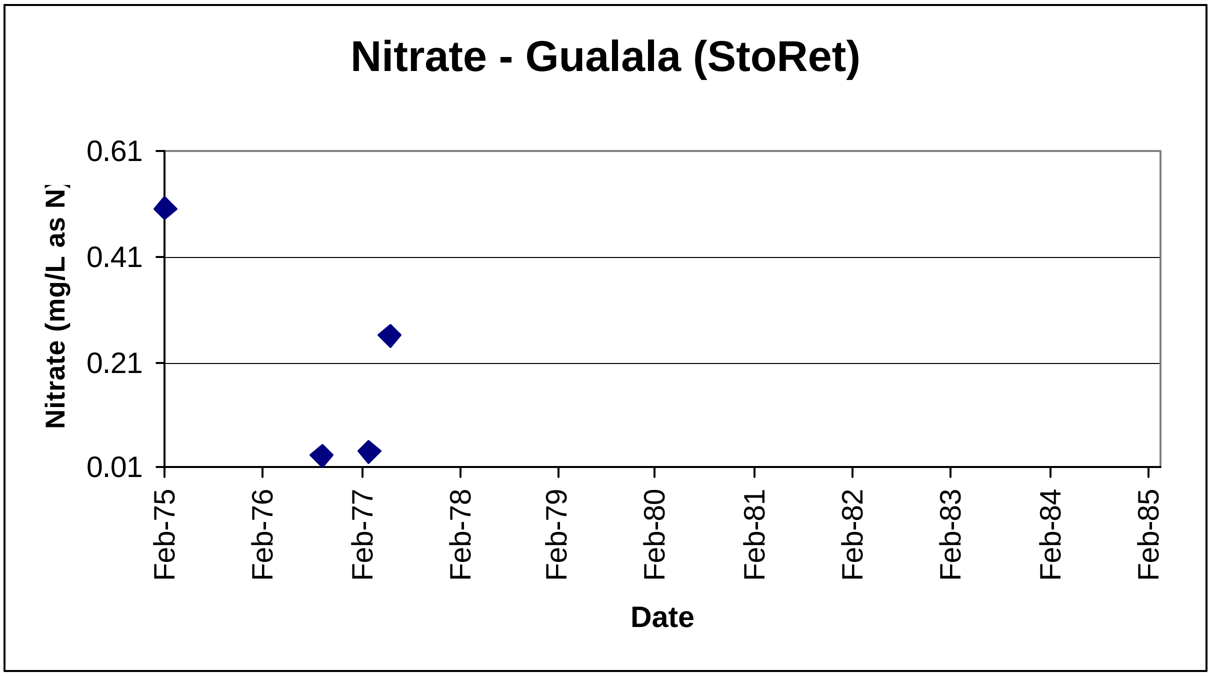
START DATE	START TIME	PHOSPHORUS, DISSOLVED ORTHOPHOSPHATE (MG/L AS P)	METALS
13-Feb-75	2500		All Nondetect
14-Sep-76	1040	0.04	All Nondetect
14-Sep-76	1815		
14-Sep-76	2130		
15-Sep-76	500		
15-Sep-76	820		
15-Sep-76	1100		
30-Nov-76	1430		
1-Dec-76	930	0.02	
1-Dec-76	1705		
1-Dec-76	2045		
2-Dec-76	545		
2-Dec-76	900		
2-Dec-76	1200		
8-Mar-77	1600		
9-Mar-77	1530	0.03	
9-Mar-77	1800		
9-Mar-77	2100		
10-Mar-77	530		
10-Mar-77	1000		
17-Mar-77	1130		
24-May-77	1315		
25-May-77	830		
25-May-77	1740	0.01	
25-May-77	1900		
26-May-77	945		
27-May-77	700		
13-Oct-77	1620	0.03	
14-Oct-77	520		
14-Oct-77	830		
4-Apr-85	1235		

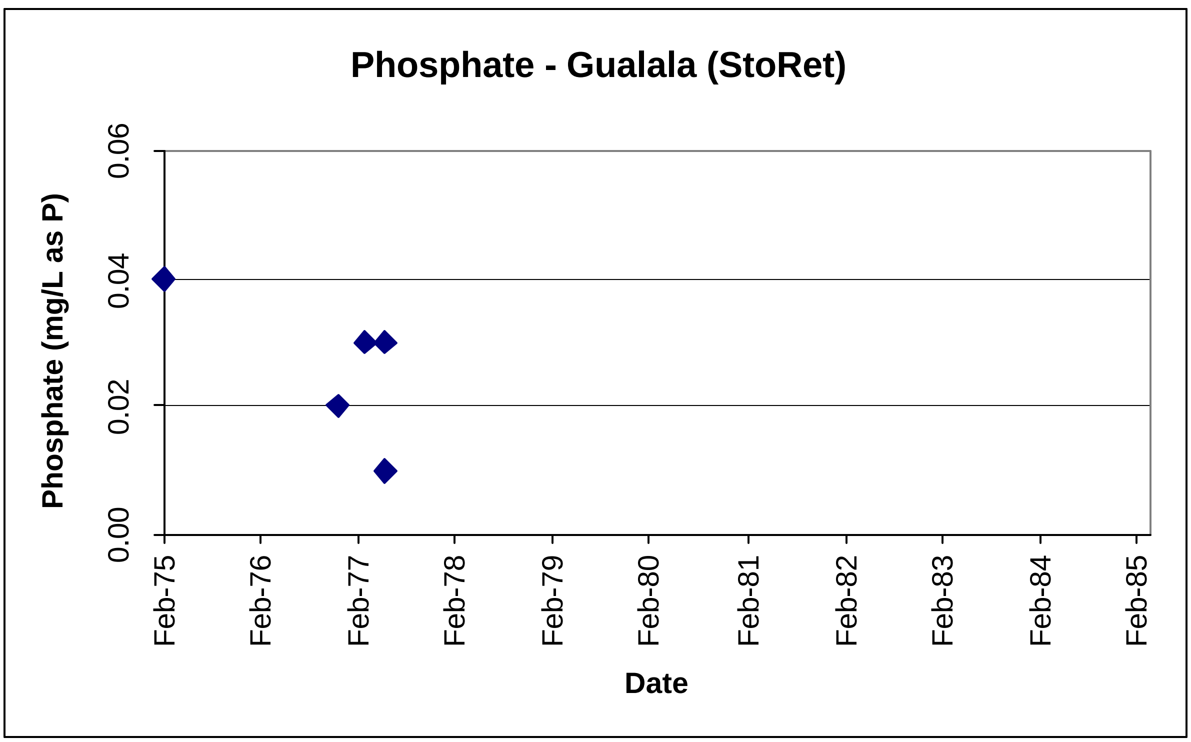

Dissolved Oxygen - Gualala (StoRet)
Dissolved Oxygen (mg/L)
14.0
12.0
10.0
8.0
6.0
Feb-75
Feb-76
Feb-77
Feb-78
Feb-79
Feb-80
Feb-81
Feb-82
Feb-83
Feb-84
Feb-85


pH - Gualala (StoRet)
pH (Standard Units)
8.5
8.1
7.7
7.3
6.9
6.5
Feb-75
Feb-76
Feb-77
Feb-78
Feb-79
Feb-80
Feb-81
Feb-82
Feb-83
Feb-84
Feb-85
Date


Conductance - Gualala (StoRet)
Conductance (UMHOS/CM @ 25C)
300
250
200
150
100
50
Feb-75
Feb-76
Feb-77
Feb-78
Feb-79
Feb-80
Feb-81
Feb-82
Feb-83
Feb-84
Feb-85
Date


Hardness - Gualala (StoRet)
Hardness (mg/L as CaCO3
100.00
80.00
60.00
40.00
20.00
Feb-75
Feb-76
Feb-77
Feb-78
Feb-79
Feb-80
Feb-81
Feb-82
Feb-83
Feb-84
Feb-85
Date


Nitrate - Gualala (StoRet)
Nitrate (mg/L as N)
0.61
0.41
0.21
0.01
Feb-75
Feb-76
Feb-77
Feb-78
Feb-79
Feb-80
Feb-81
Feb-82
Feb-83
Feb-84
Feb-85
Date


Phosphate - Gualala (StoRet)
Phosphate (mg/L as P)
0.06
0.04
0.02
0.00
Feb-75
Feb-76
Feb-77
Feb-78
Feb-79
Feb-80
Feb-81
Feb-82
Feb-83
Feb-84
Feb-85
Date

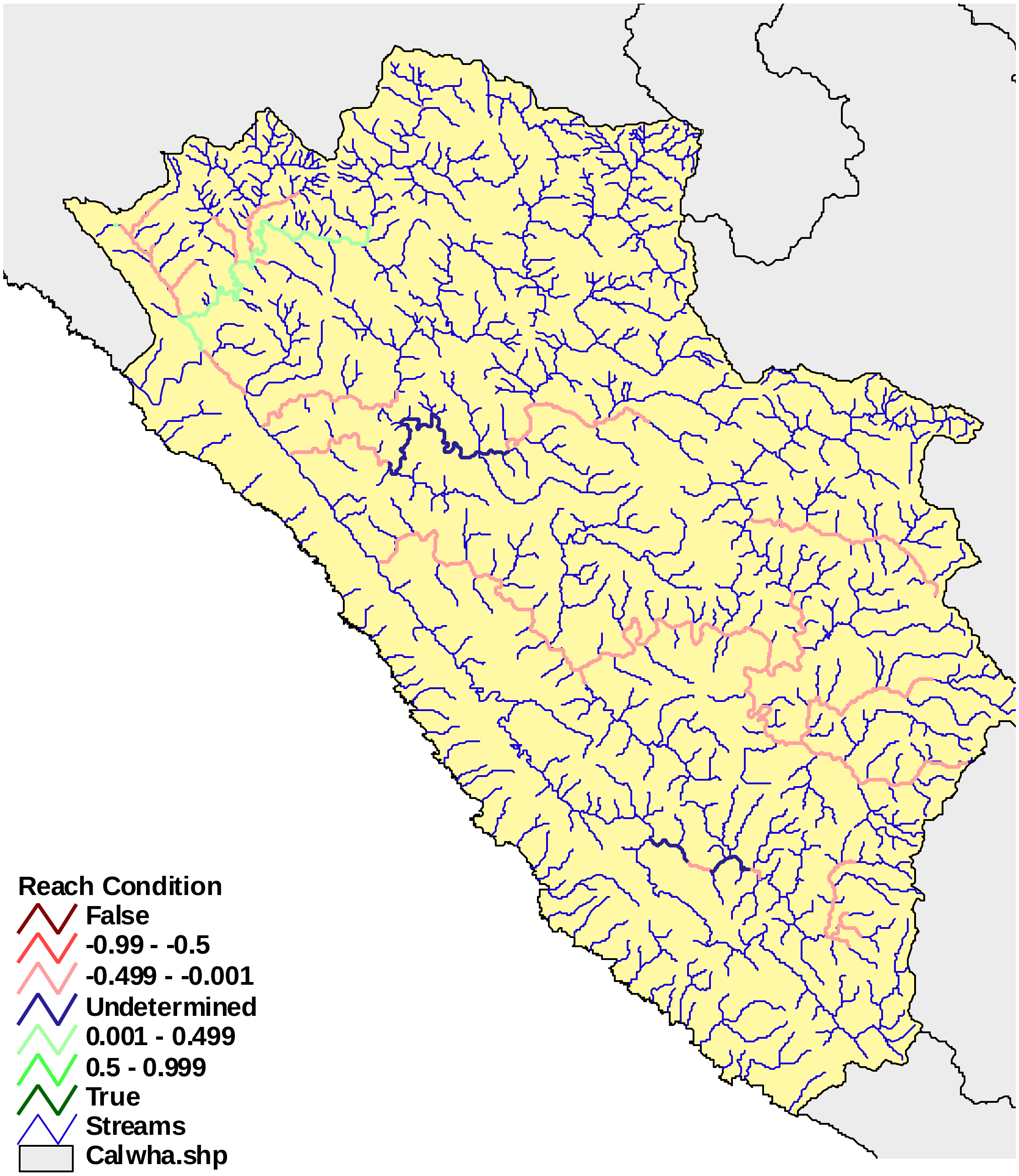
APPENDIX 10

EMDS KNOWLEDGE BASE SYSTEM RESULTS

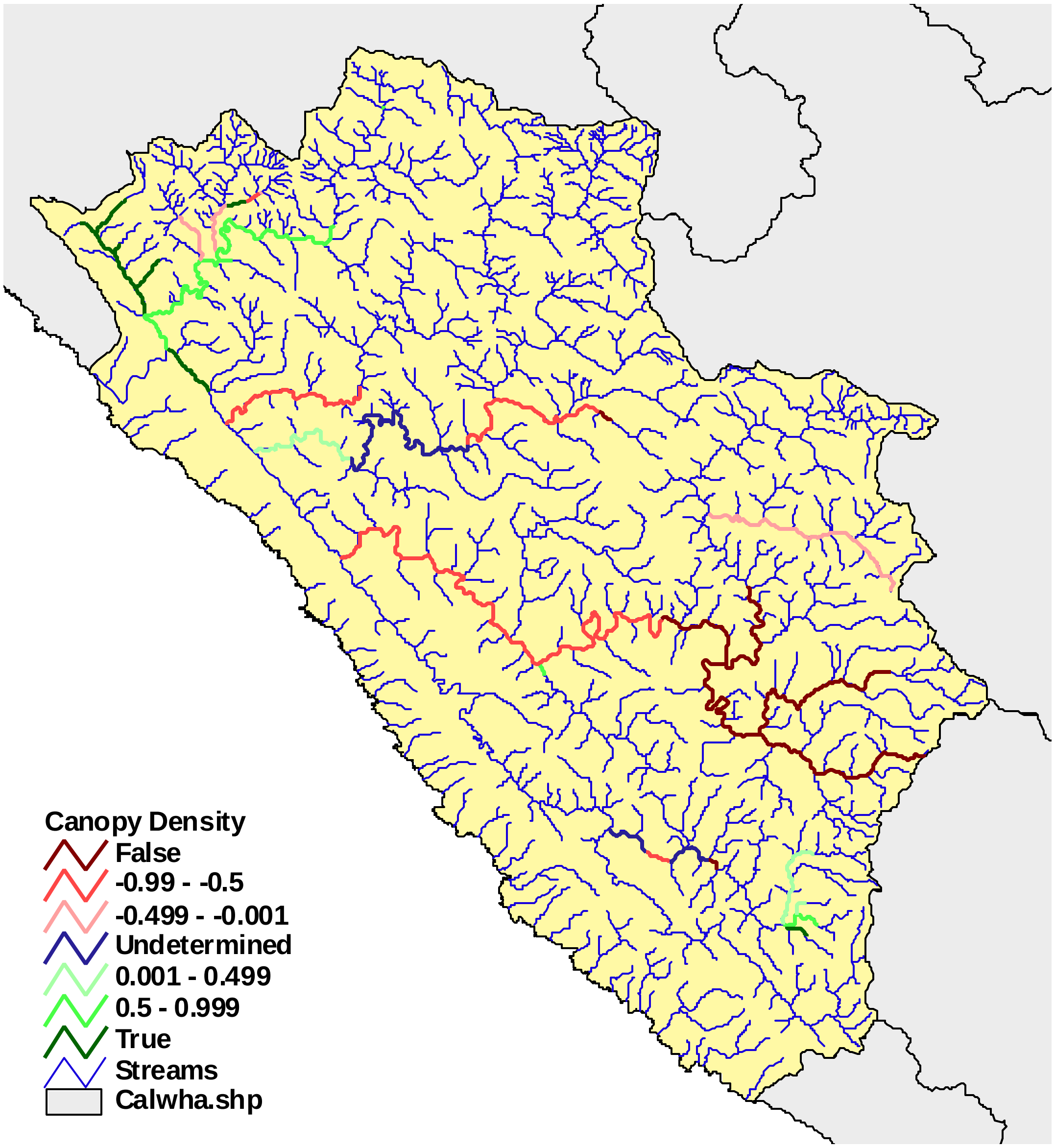
Reach Model

A draft summary explanation of the dependency curves is presented on the following pages. The preliminary model runs appear as maps, without explanation at this point.

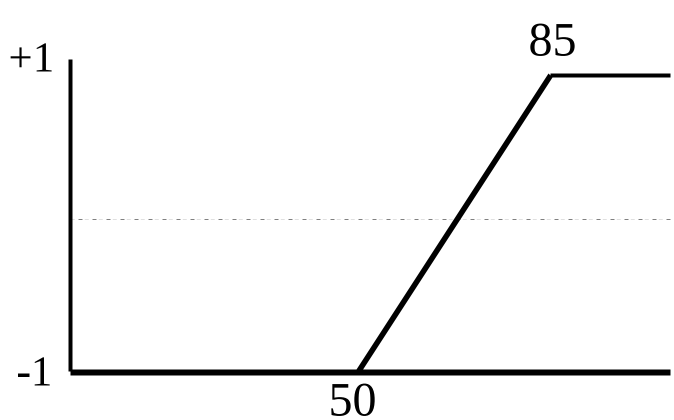
Reach Condition



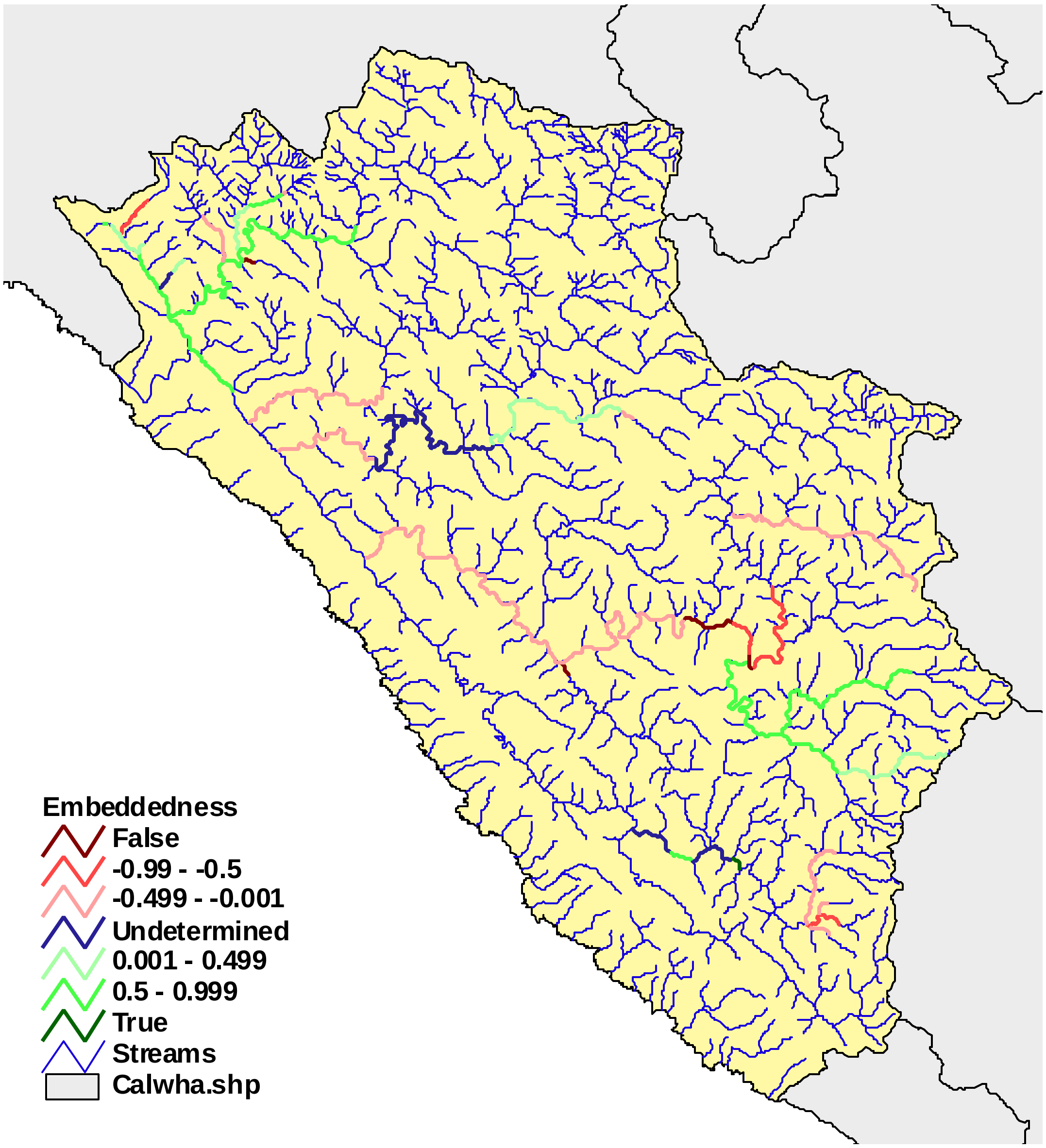
Canopy Density



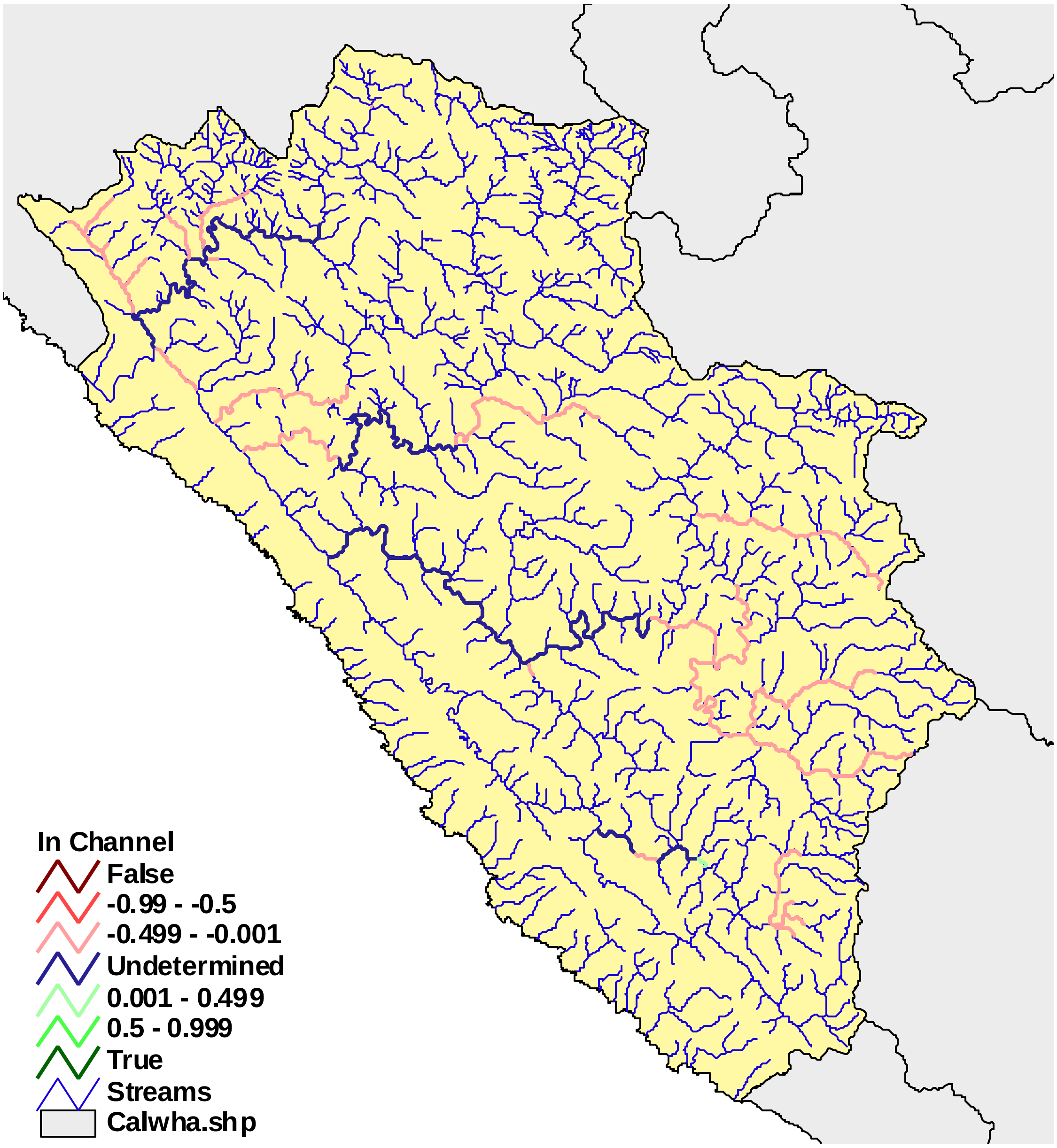
Percent Canopy Density



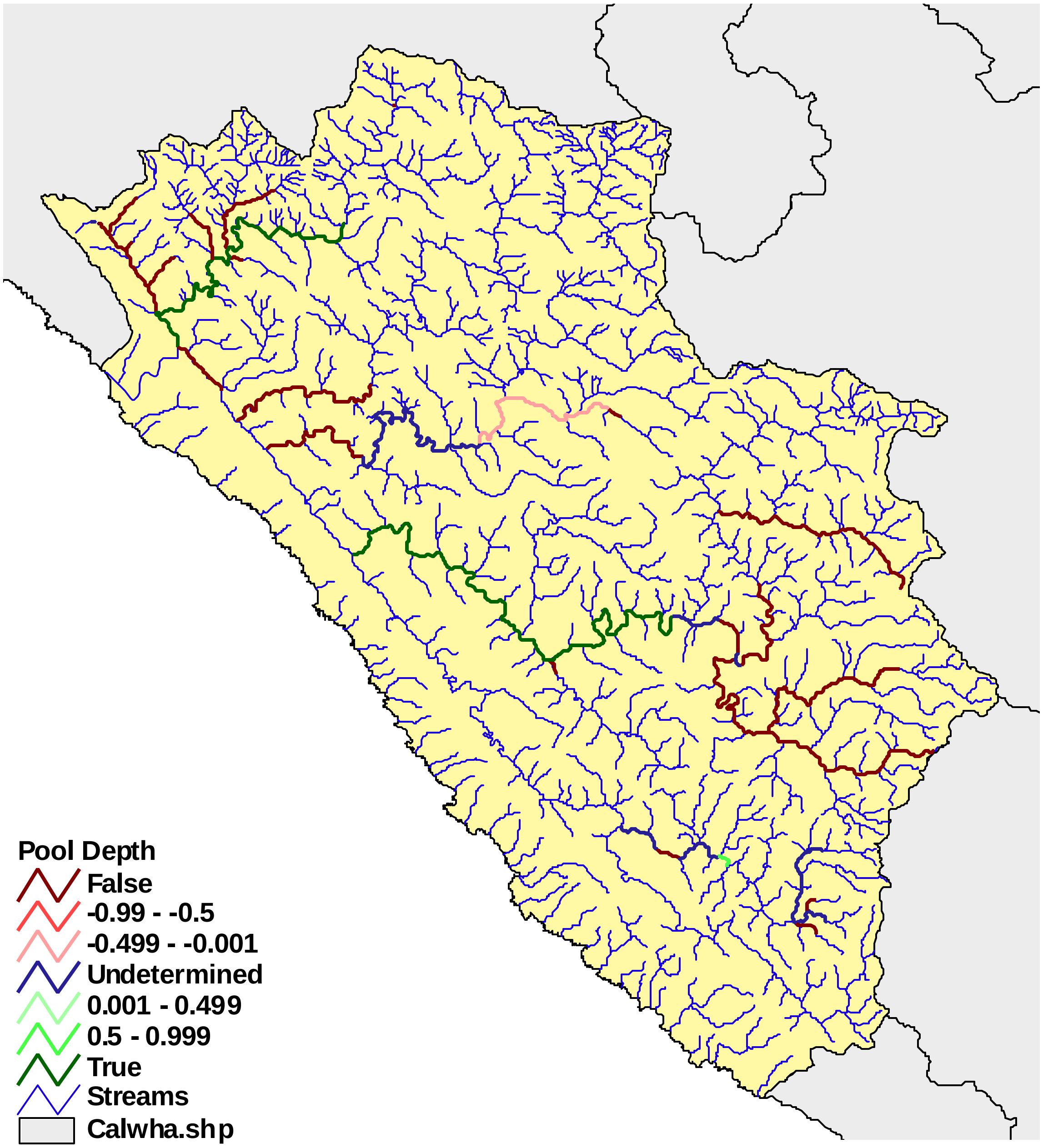
Embeddedness



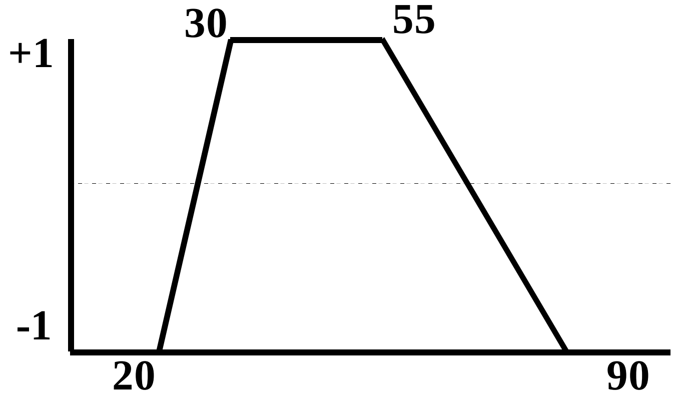
In Channel


In Channel
False
-0.99 - -0.5
-0.499 - -0.001
Undetermined
0.001 - 0.499
0.5 - 0.999
True
Streams
Calwha.shp

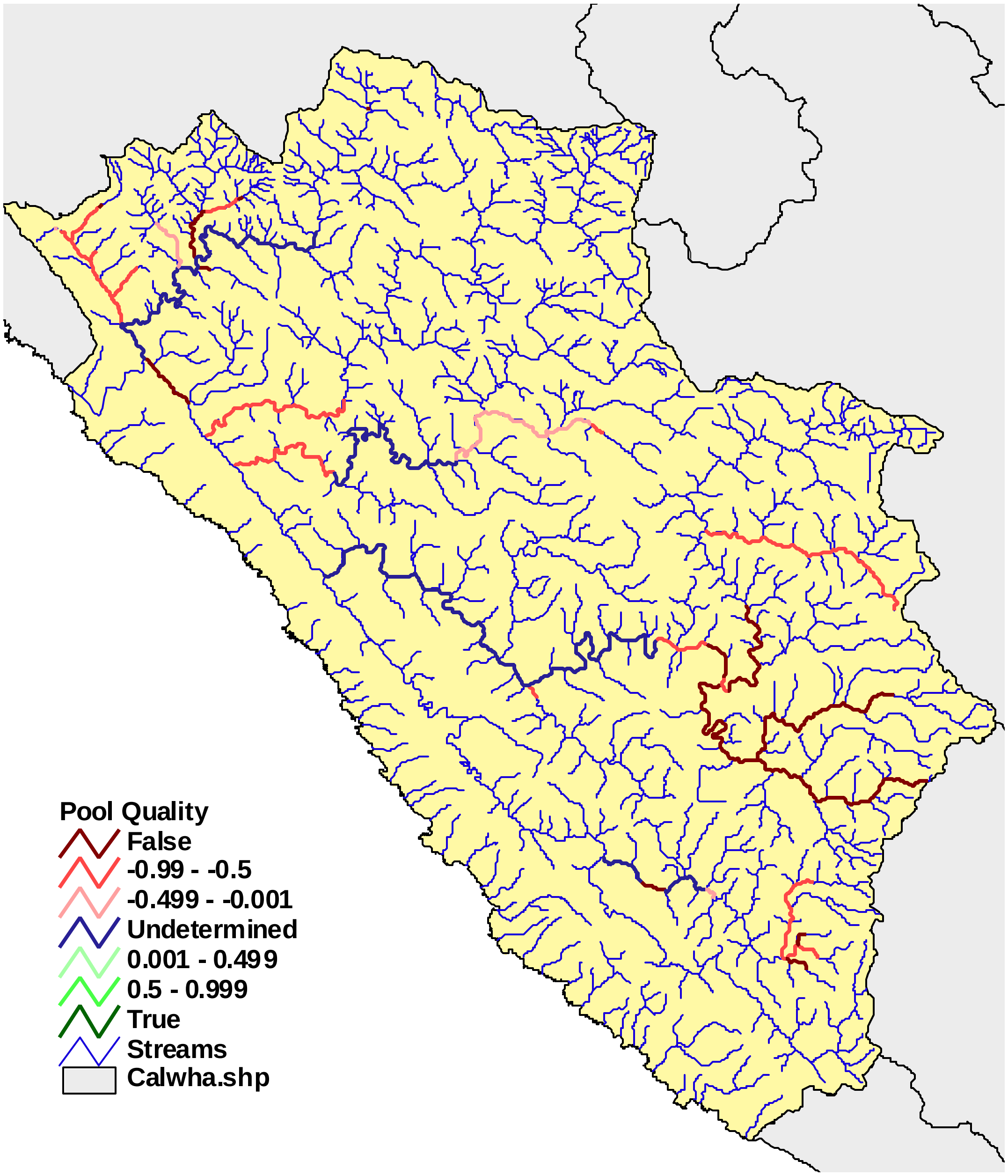
Pool Depth



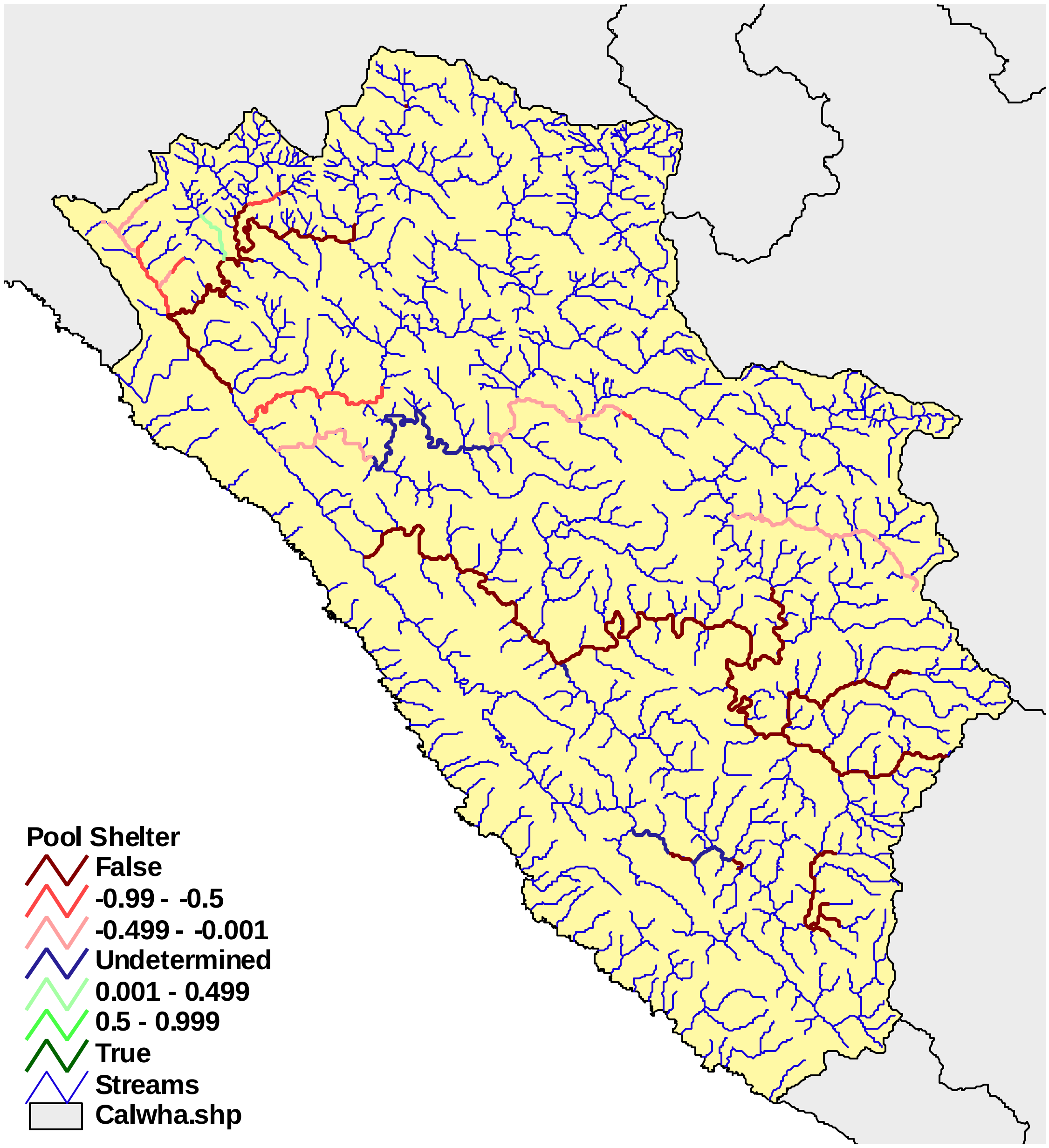
Percent Reach in Primary Pools



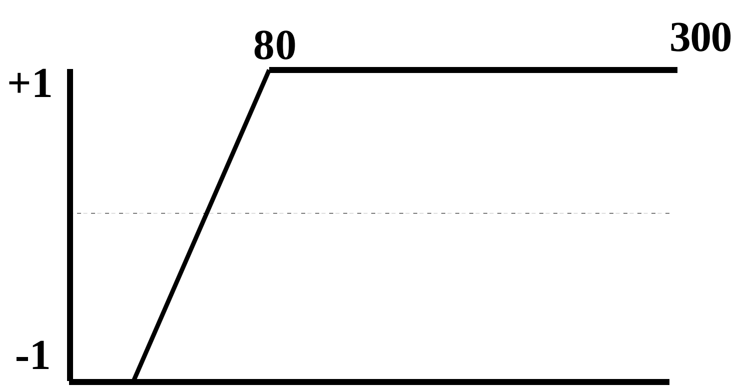
Pool Quality



Pool Shelter Complexity

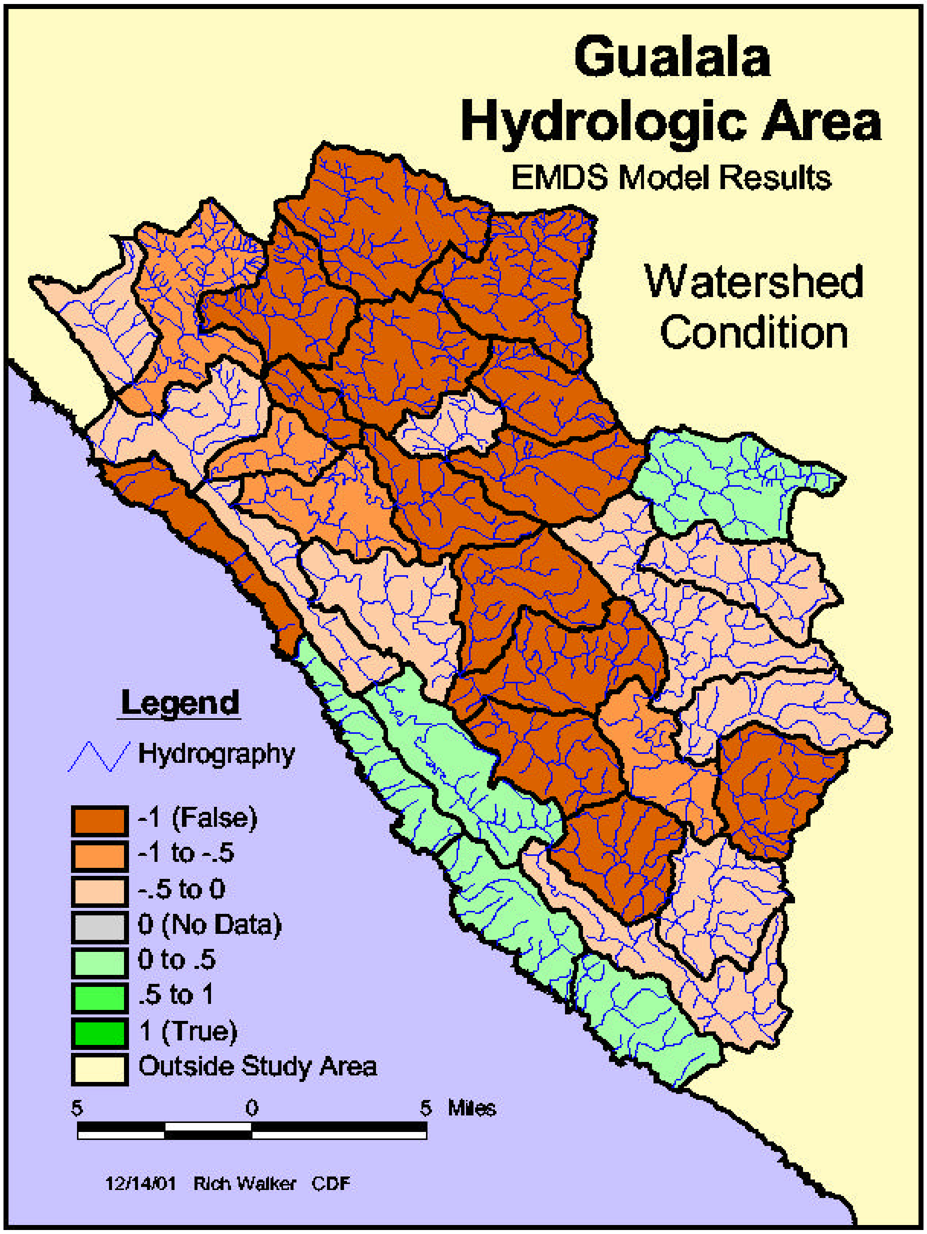


Pool Shelter Complexity



Watershed Model

The preliminary watershed model runs appear after the reach model runs as maps on the following pages with summary explanations.



WATERSHED CONDITION

Proposition:

Conditions in the Planning Watershed are suitable to sustain healthy populations of native anadromous salmonids

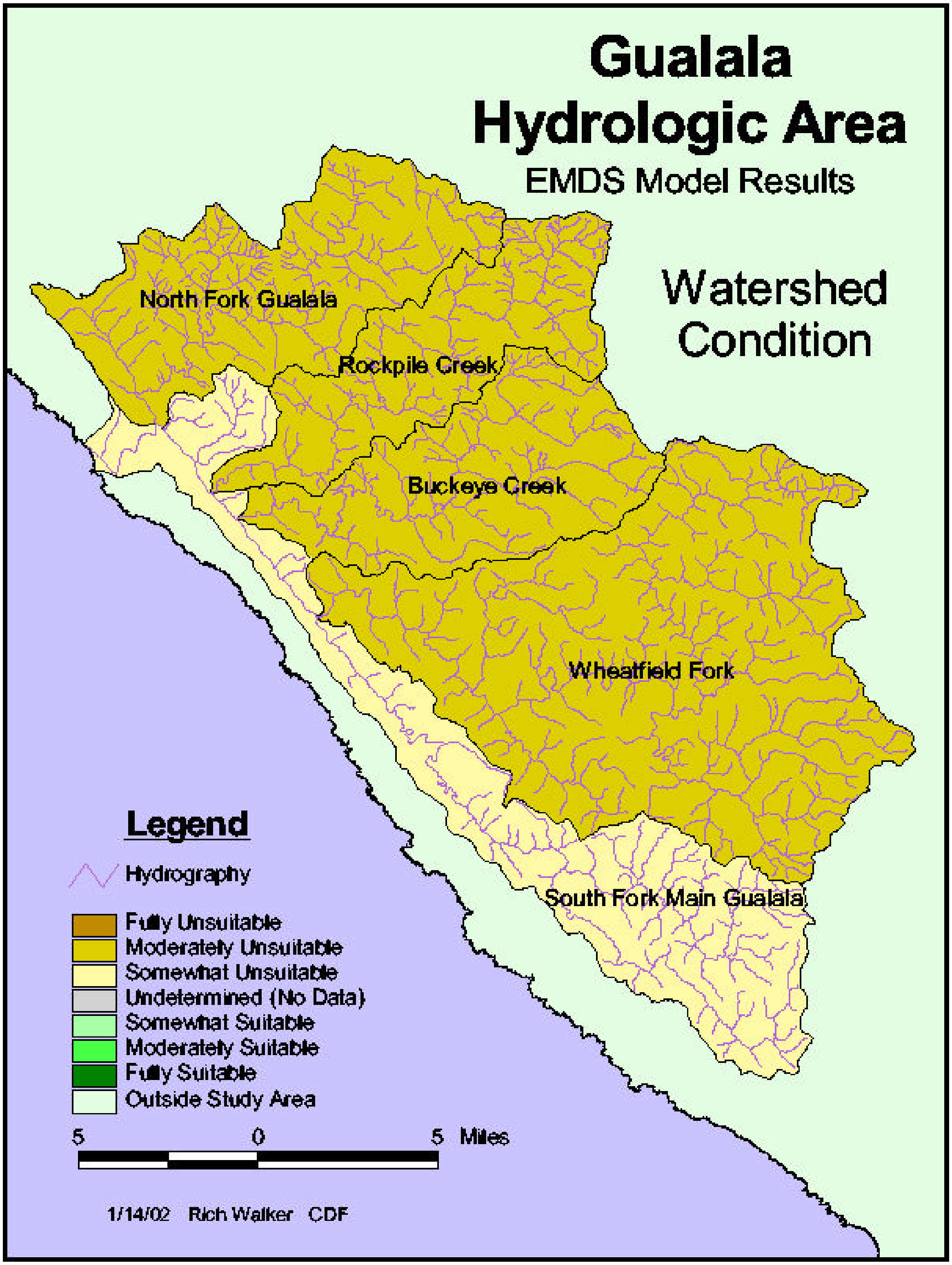
Evaluated by the following:

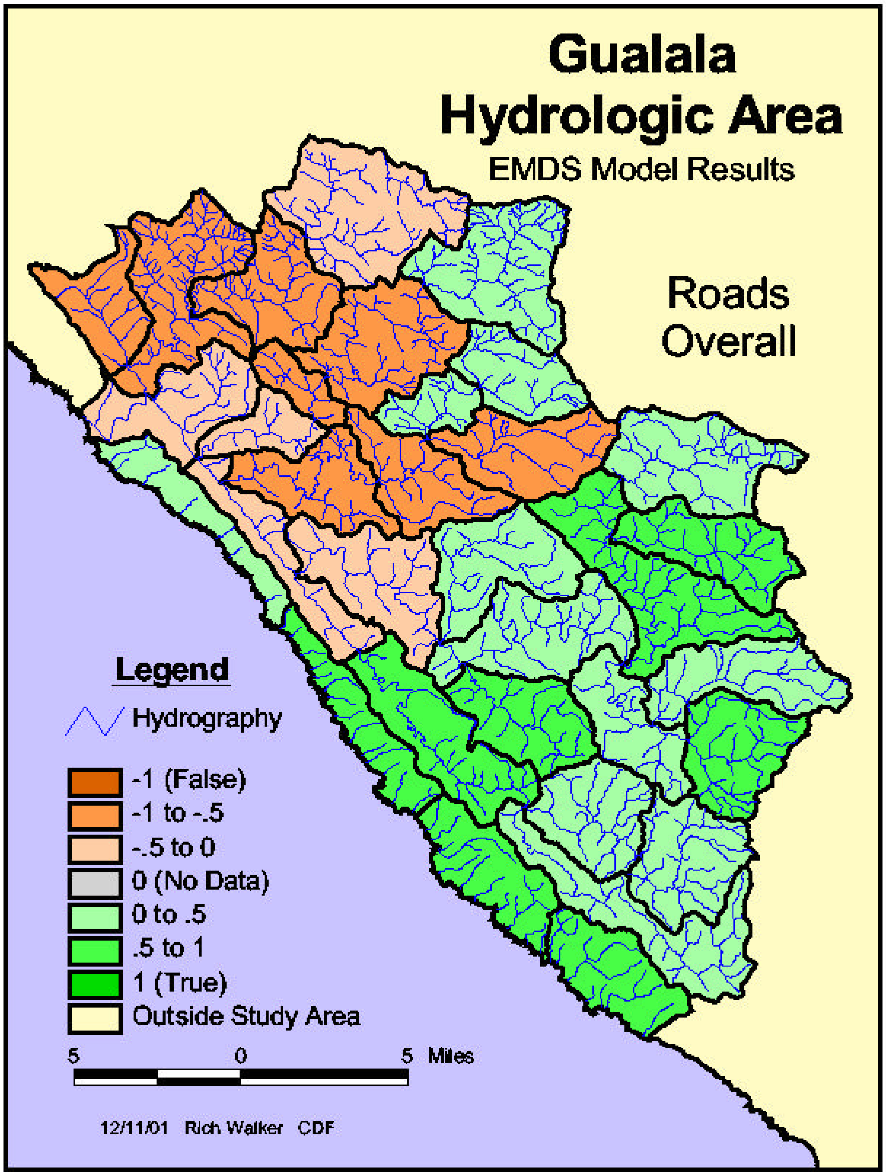
Combines all factors through an "AND" node to provide a comprehensive watershed condition score.

NOTE: Truth values at the highest levels represent the combined scores from lower level networks and thus are not calculated using a dependency curve.

NOTE: Includes preliminary results from Reach Model. Water Temperature is <u>not</u> represented in this model run.

EMDS Watershed Condition Sub-Basin Results.





ROADS OVERALL -

Proposition:

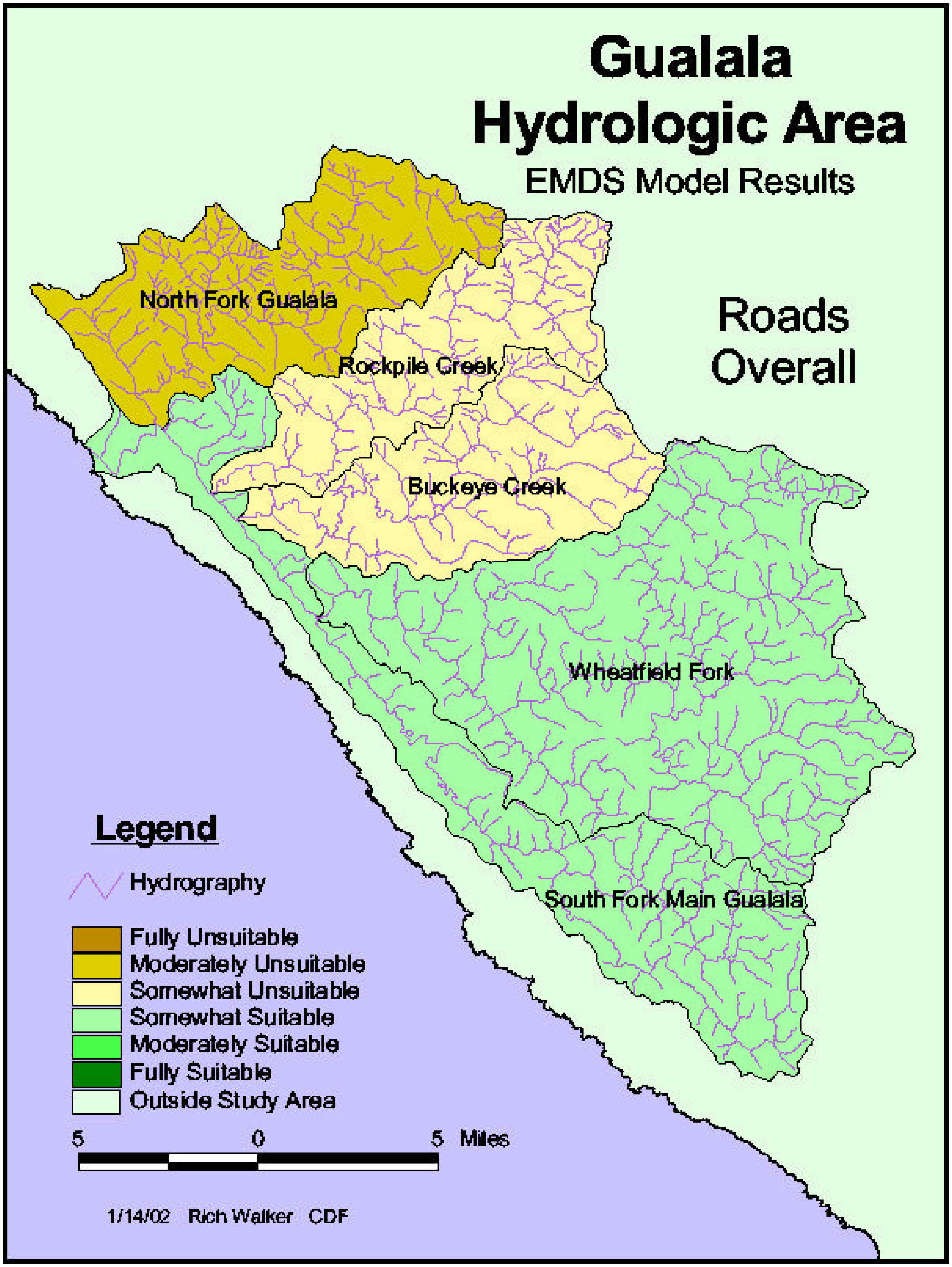
Roads in the Planning Watershed do not significantly impair its functioning for sustaining healthy populations of native anadromous salmonids

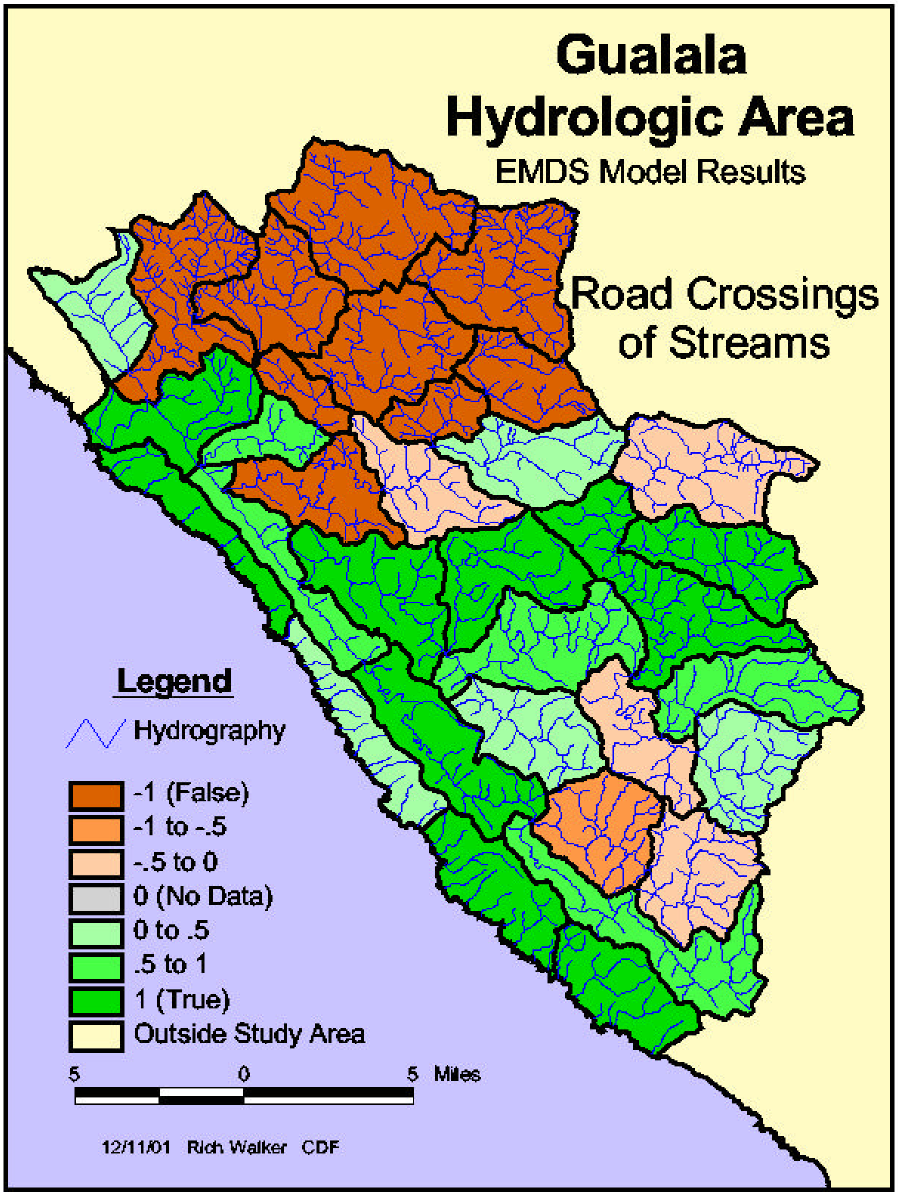
Evaluated by the following:

Combines all road factors through an "AND" node to provide a comprehensive road impact score.
Road impacts are evaluated using USGS 1:24k road and stream data.

NOTE: Truth values at the highest levels represent the combined scores from lower level networks and thus are not calculated using a dependency curve.

EMDS Roads Overall Sub-Basin Results





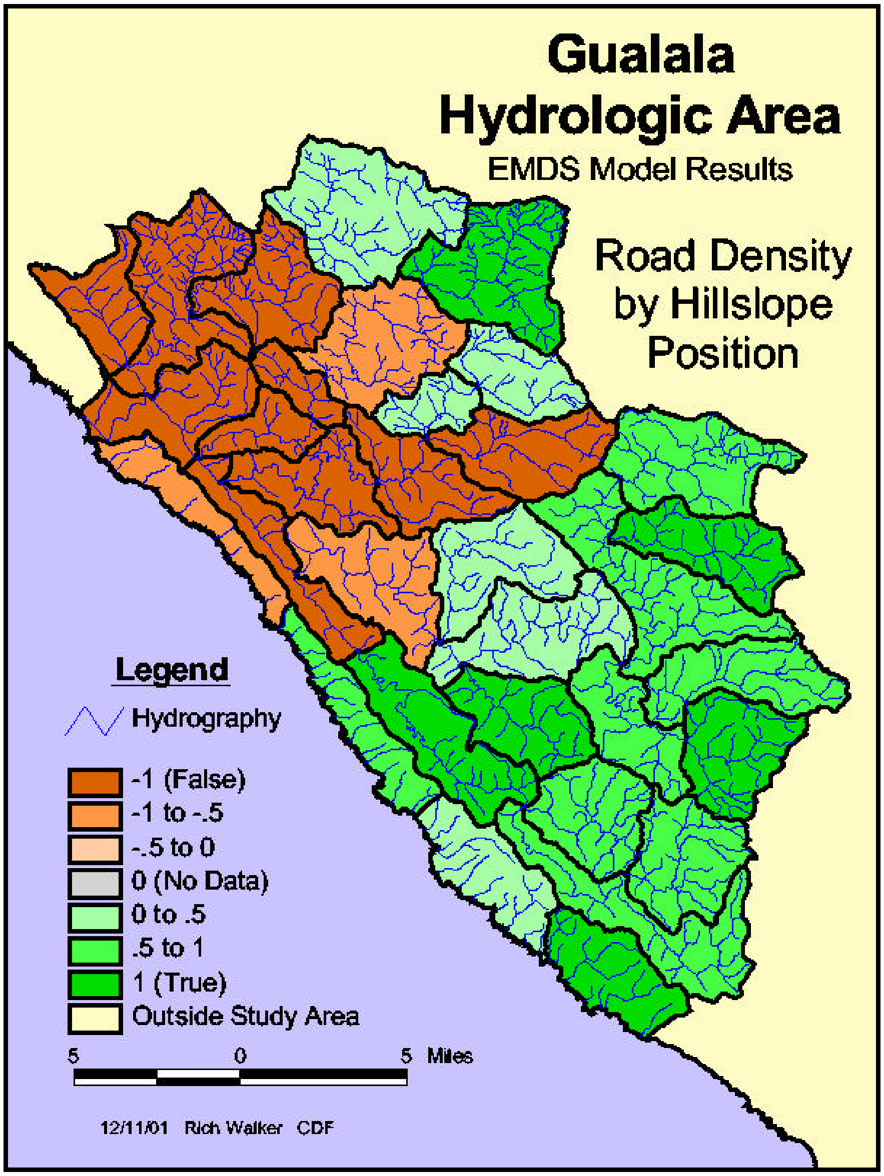
ROAD CROSSINGS OF STREAMS-

Proposition:

Number of road crossing of streams in the Planning Watershed do not significantly impair its functioning for sustaining healthy populations of native anadromous salmonids

Evaluated by the number of crossings per kilometer of stream using USGS 1:24k road and stream data.

<u>Break Points:</u> 0 low, 1 high
<u>Units:</u> # of crossings per km



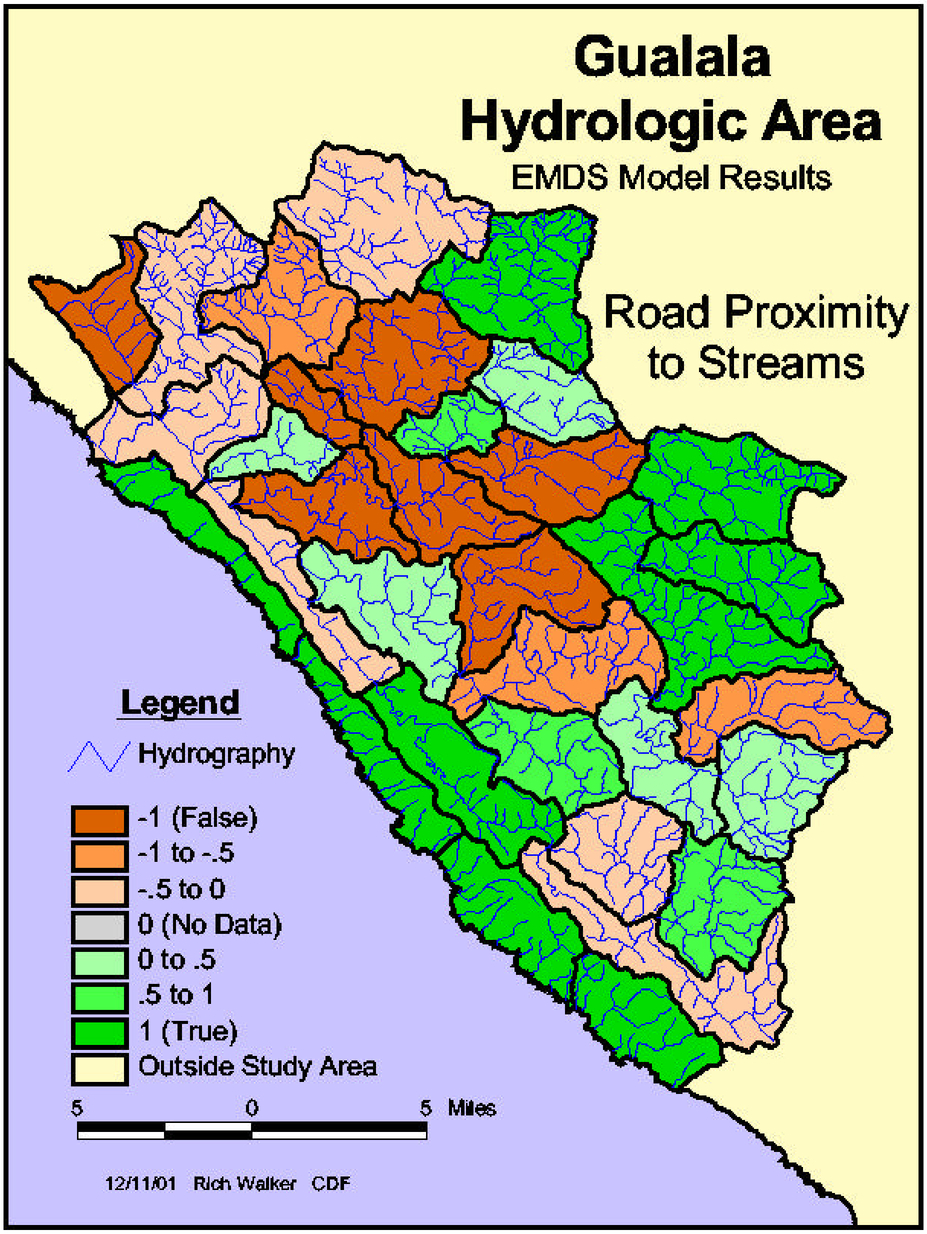
ROAD DENSITY BY HILLSLOPE POSITION

Proposition:

Road densities by hillslope position Planning Watershed do not significantly impair its functioning for sustaining healthy populations of native anadromous salmonids

Weighted by 3 classes of hillslope positions. Evaluated using USGS 10m DEMs,1:24k road and stream data.

Break Points: 1 low, 3 high
Units: km/km^2.



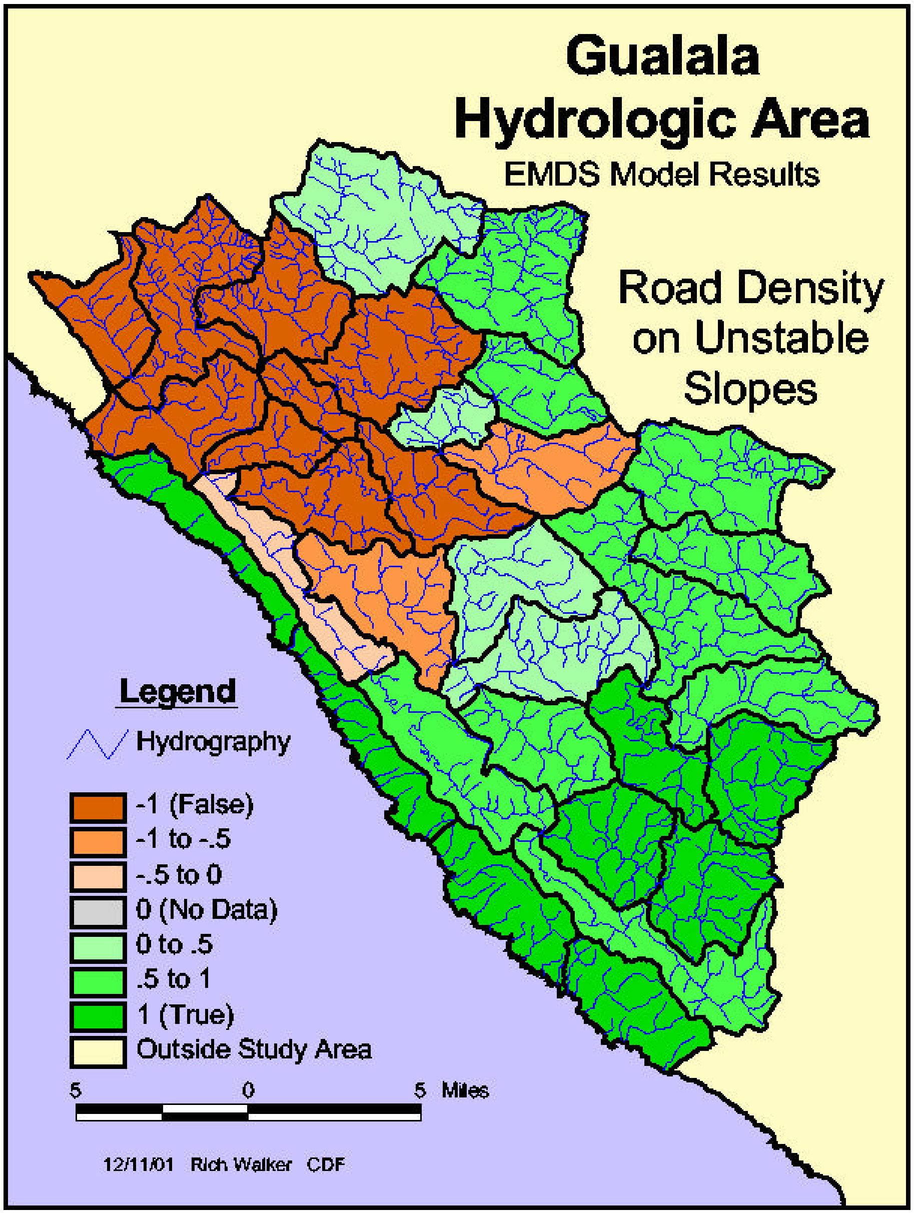
ROAD PROXIMITY TO STREAMS-

Proposition:

Roads proximate to streams in the Planning Watershed do not significantly impair its functioning for sustaining healthy populations of native anadromous salmonids

Uses USGS 1:24k road and stream data. Evaluates percent of stream length, in a planning watershed that has a road within 200 ft.

Break Points: 0% low, 10% high
Units: km/km (%)



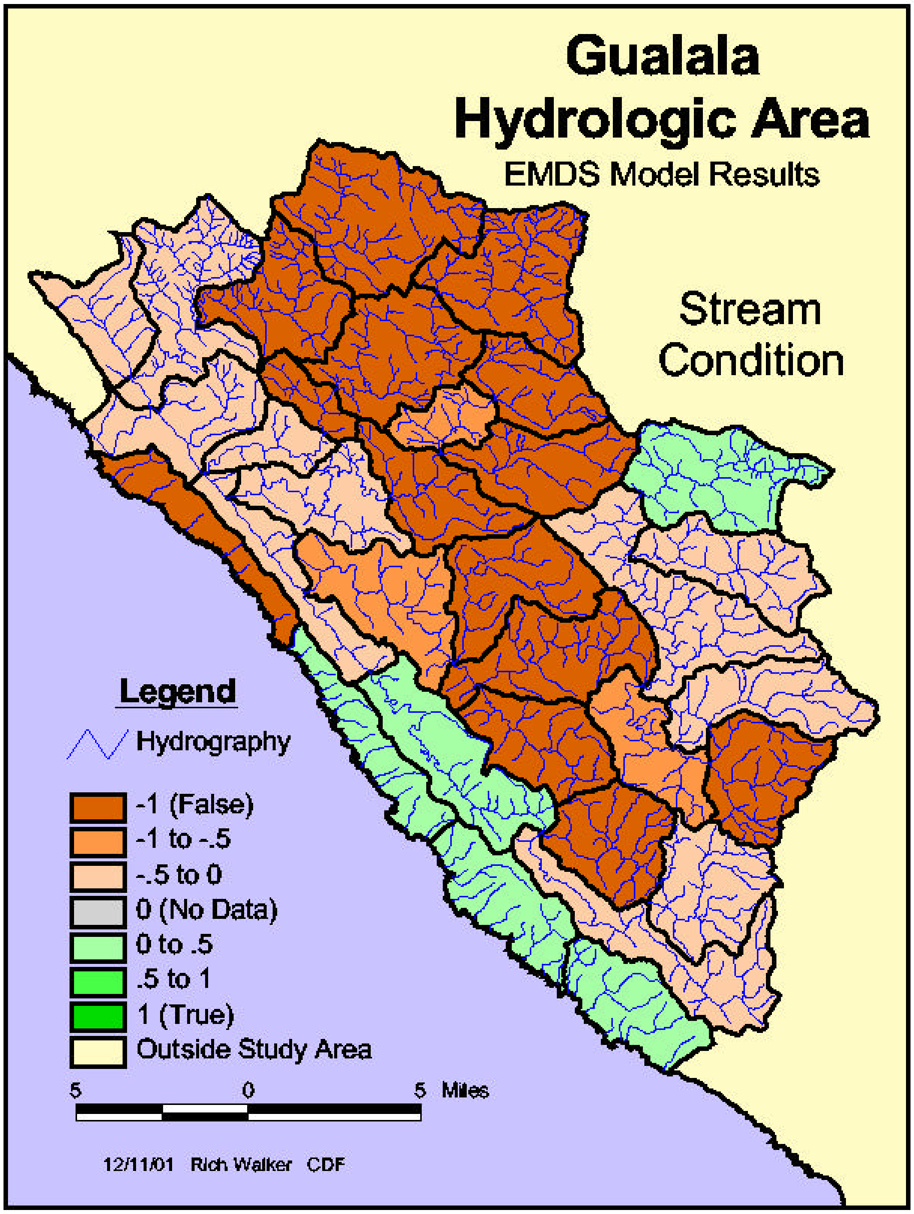
ROADS on POTENTIALLY UNSTABLE SLOPES -

Proposition:

Roads on potentially unstable slopes in the Planning Watershed do not significantly impair its functioning for sustaining healthy populations of native anadromous salmonids

Assessed using USGS 1:24k road data and SHALSTAB classes, where log q/T values are <= -2.8. Evaluates the density of roads crossing potentially unstable slopes.

<u>Break Points:</u> 0.0437 low, 0.0765 high
<u>Units</u>: km / km^2



STREAM CONDITION -

Proposition:

Stream reach conditions in the Planning Watershed are suitable for sustaining healthy populations of native anadromous salmonids

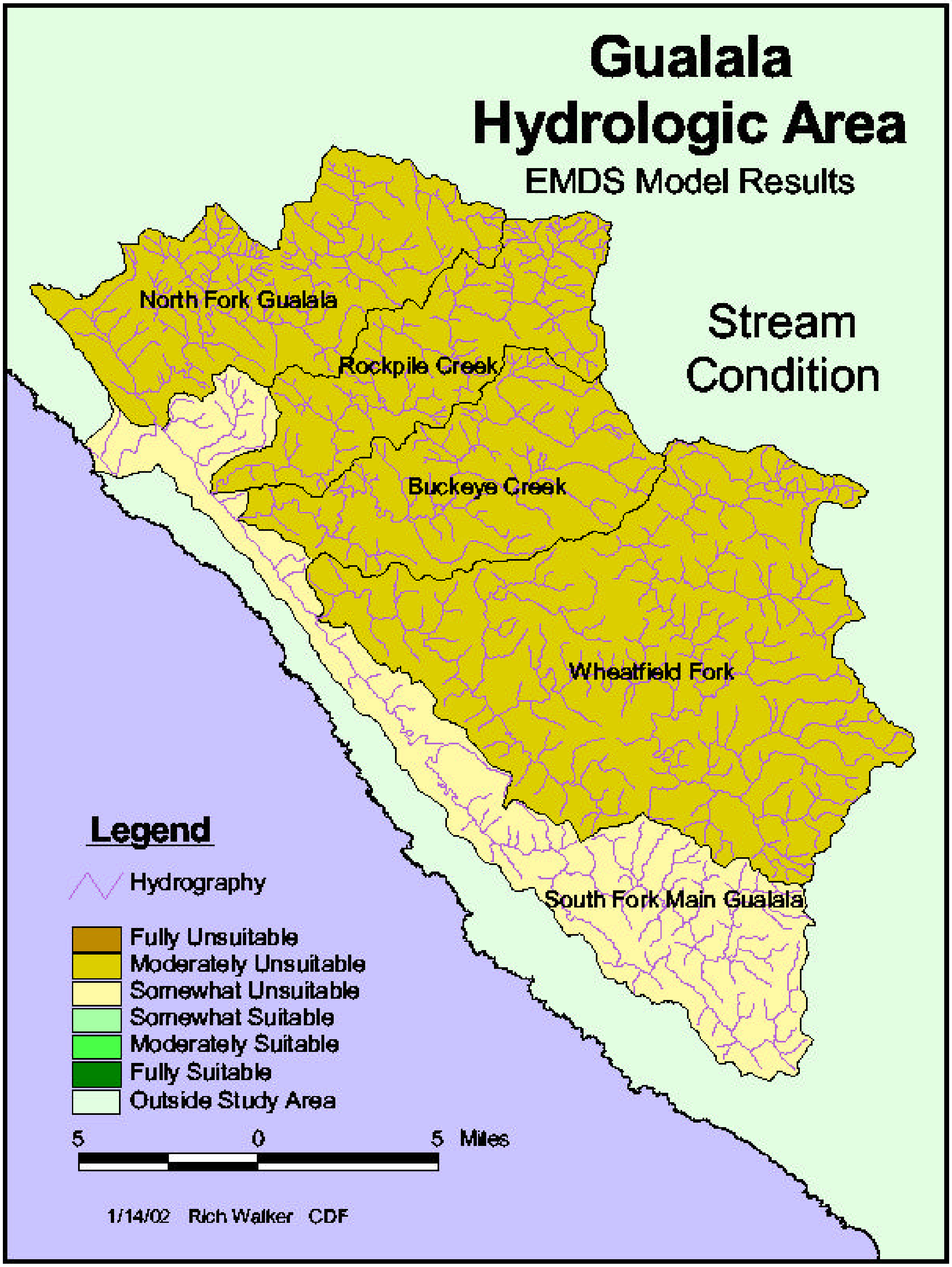
Evaluated by the following parameters.

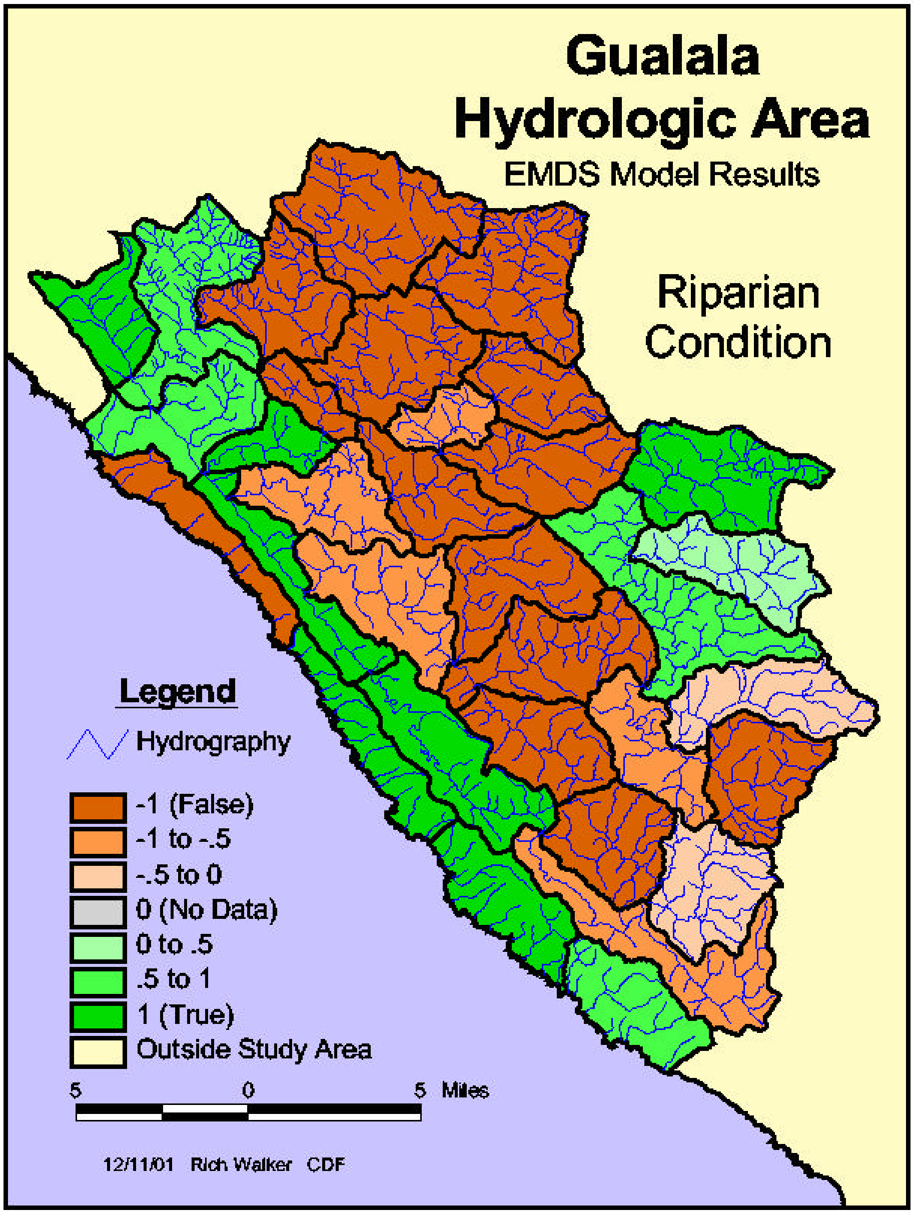
REACH CONDITION
From the Reach Model – length-weighted condition of stream reaches in the planning watershed.

STREAM FLOW
Currently we have no data for this parameter

RIPARIAN CONDITION
The minimum condition of Riparian Canopy and Large Woody Debris Potential

EMDS Stream Condition Sub-Basin Results





RIPARIAN CONDITION -

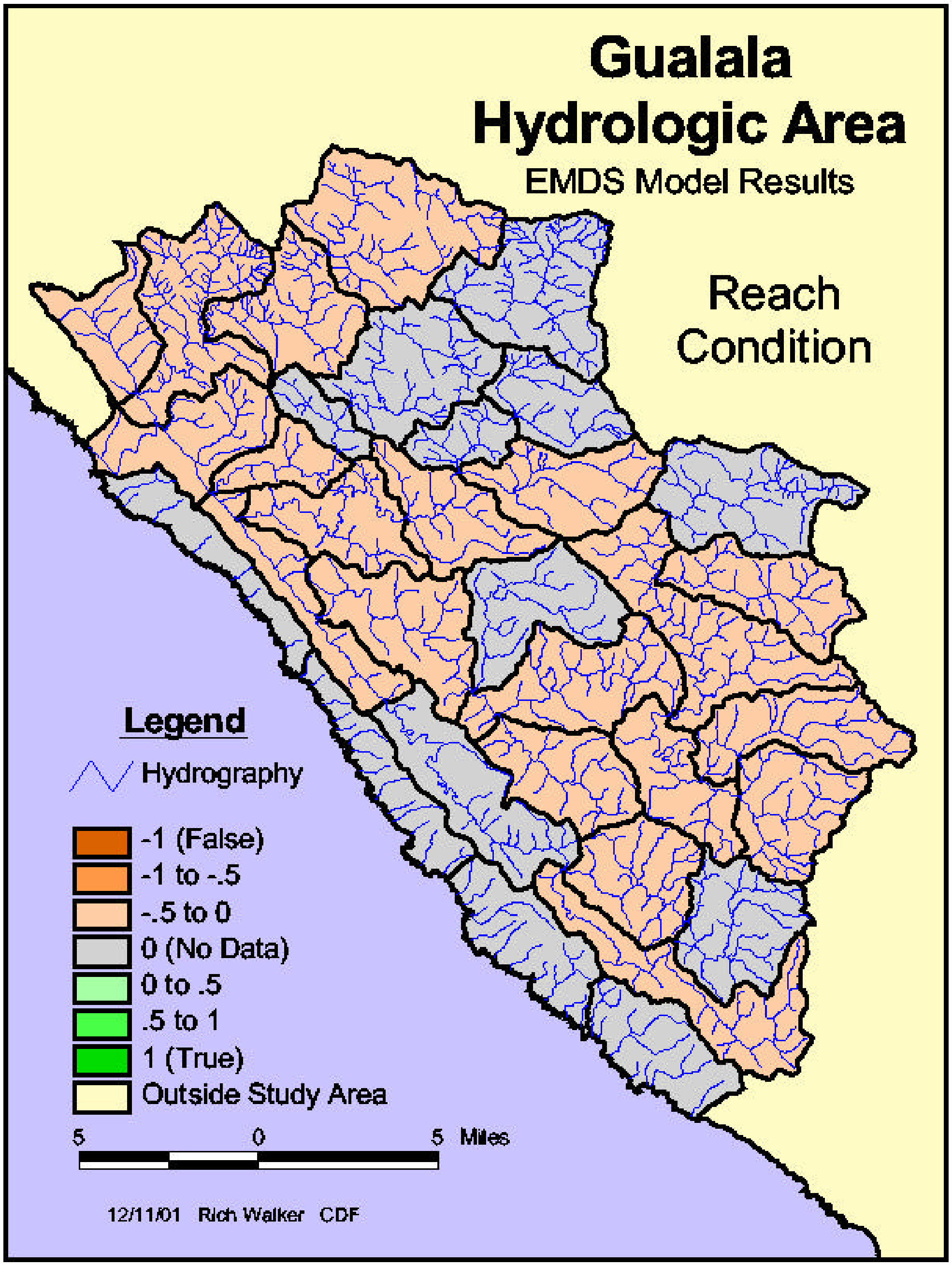
Proposition:

Riparian conditions in the Planning Watershed are suitable for sustaining healthy populations of native anadromous salmonids

Evaluated as the most restrictive of two parameters.

LARGE WOODY DEBRIS POTENTIAL
Percentage of stream (in a planning watershed) bordered by mature forest stands where average tree size
is >= 24" dbh.

RIPARIAN CANOPY COVER
Percent of stream (in a planning watershed) bordered by forest stands that exceed 70% canopy cover.



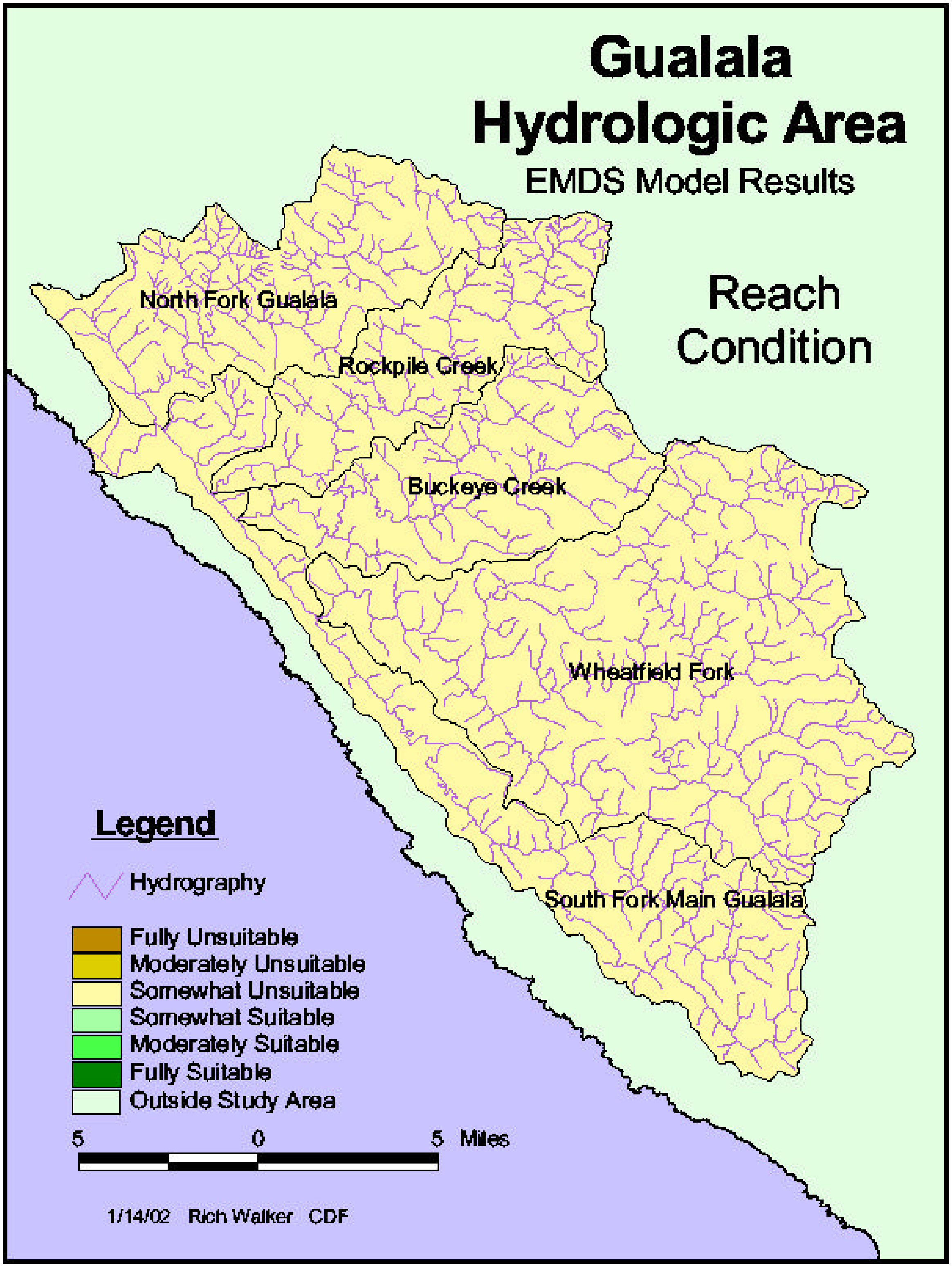
REACH CONDITION

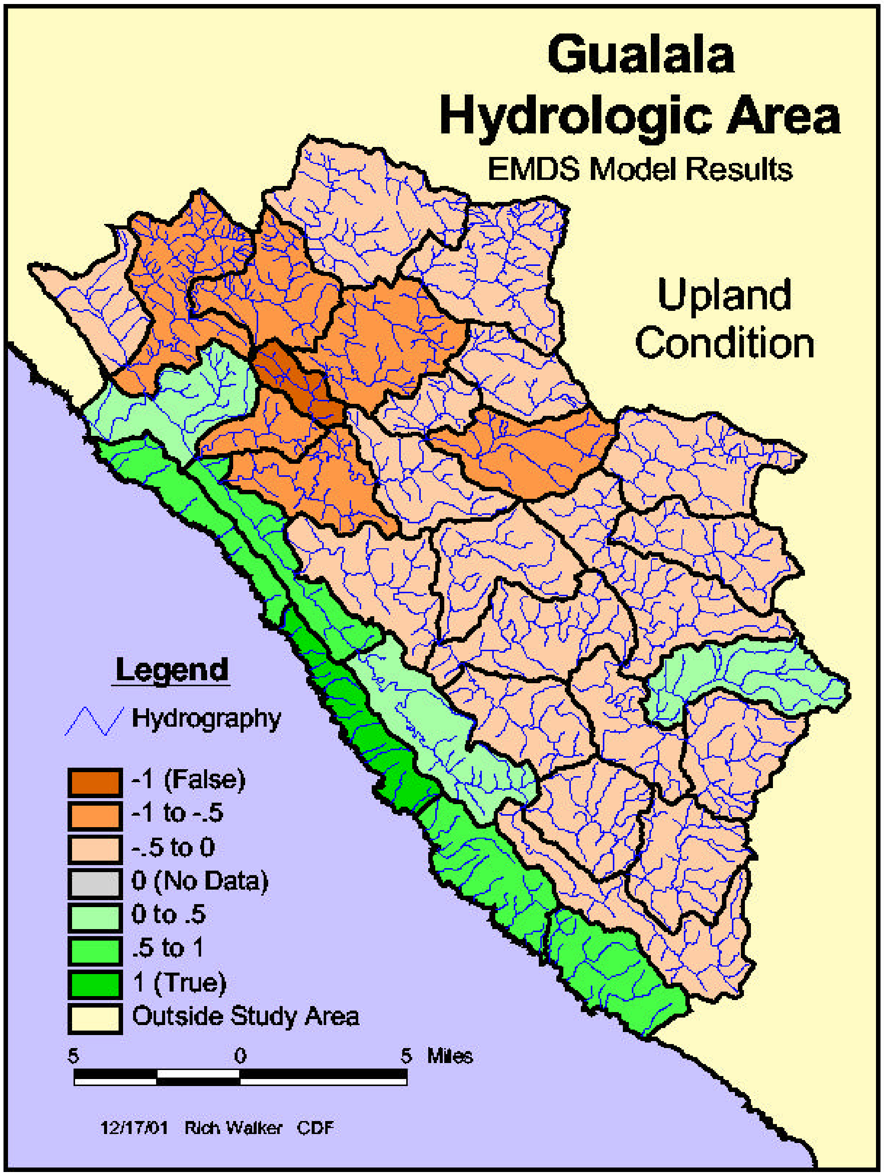
Proposition:

Conditions in the stream reaches in the Planning Watershed are suitable for sustaining healthy populations of native anadromous salmonids

Evaluated by the Reach EMDS Model, using truth values weighted by reach length.

EMDS Reach Condition Sub-Basin Results





UPLAND CONDITION –

Proposition:

The condition of the upland in the Planning Watershed is suitable for sustaining healthy populations of native anadromous salmonids

Evaluated as the mean value of:

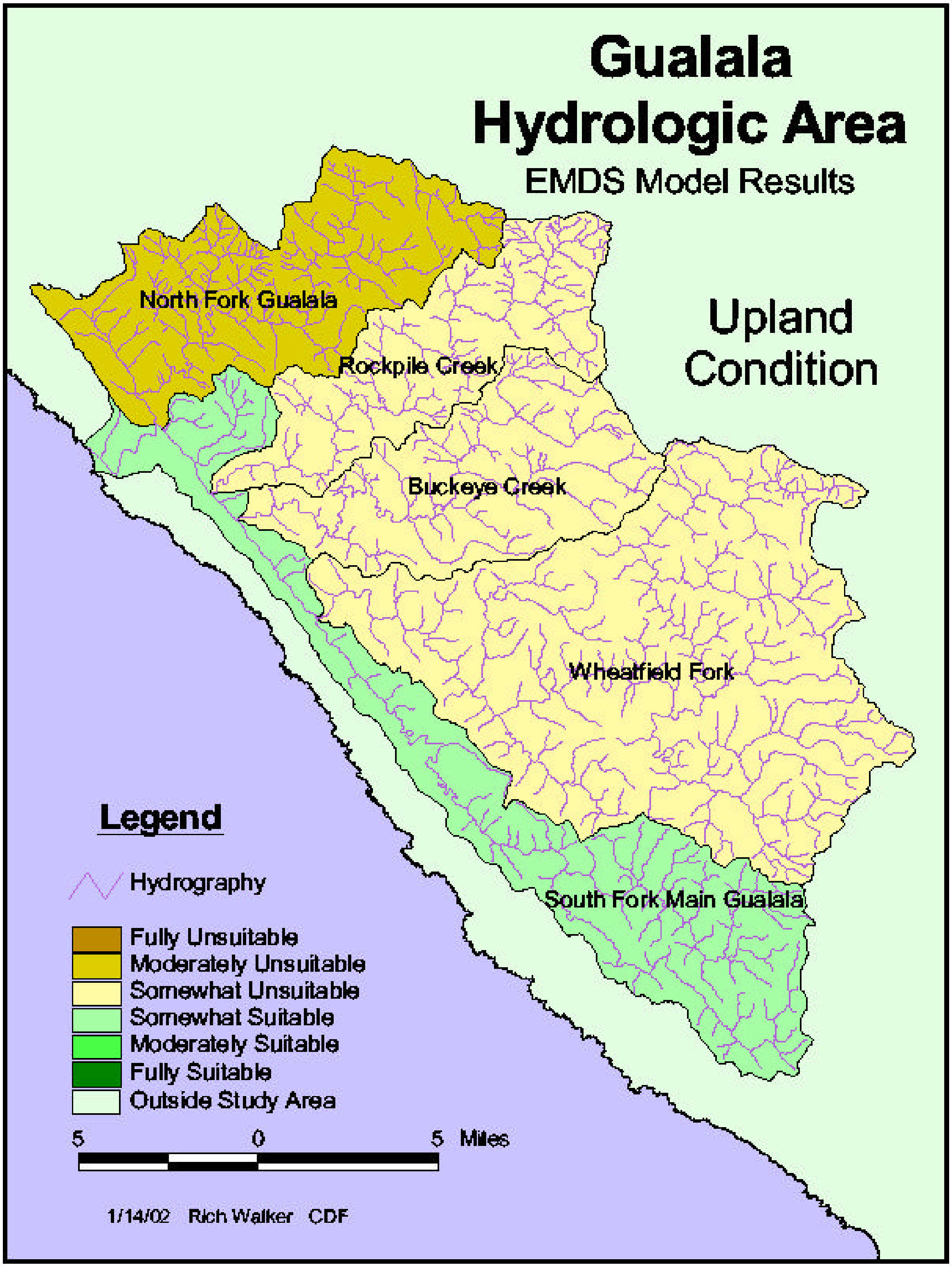
UPLAND COVER – from Canopy and Seral Openings

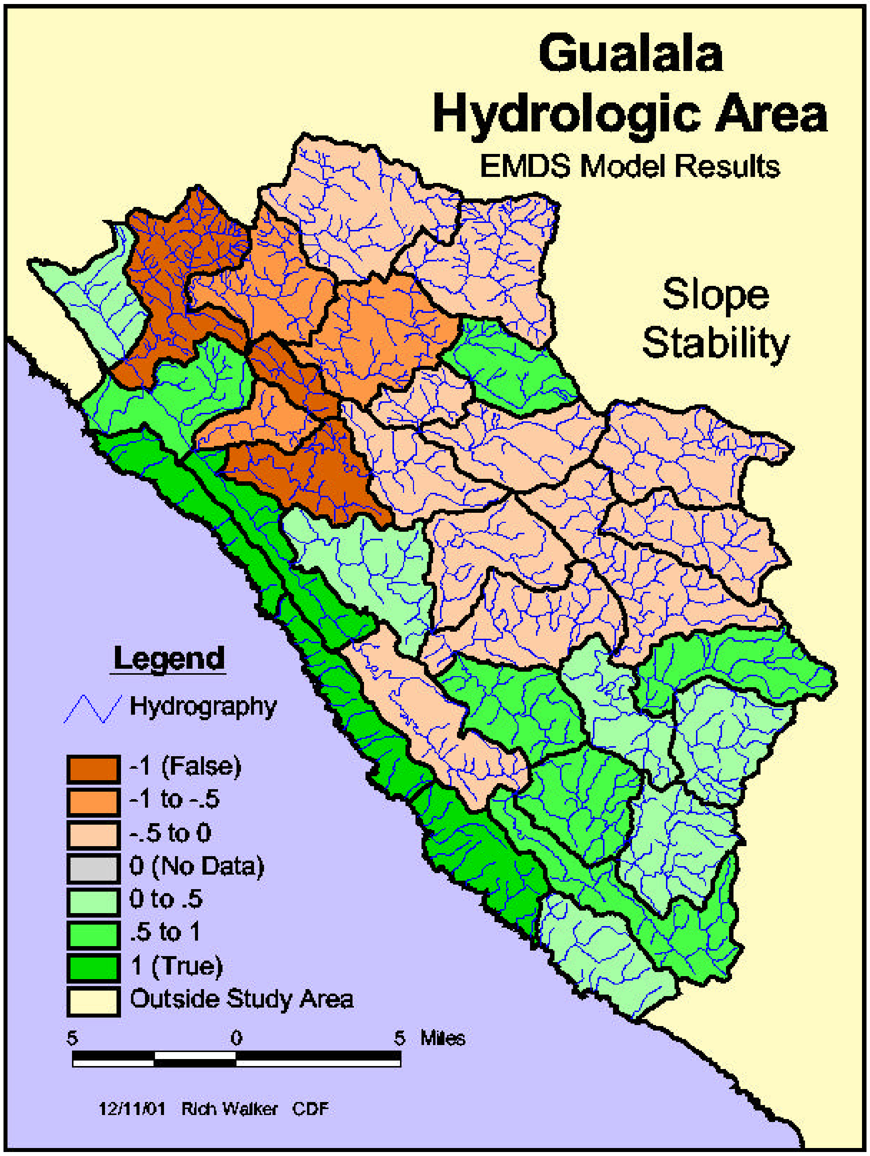
LAND USE – from current intensive and extensive land use, and recent and historic timber harvest

SLOPE STABILITY – % area of unstable slopes

NOTE: Truth values at the highest levels represent the combined scores from lower level networks and thus are not calculated using a dependency curve.

EMDS Upland Condition Sub-Basin Results





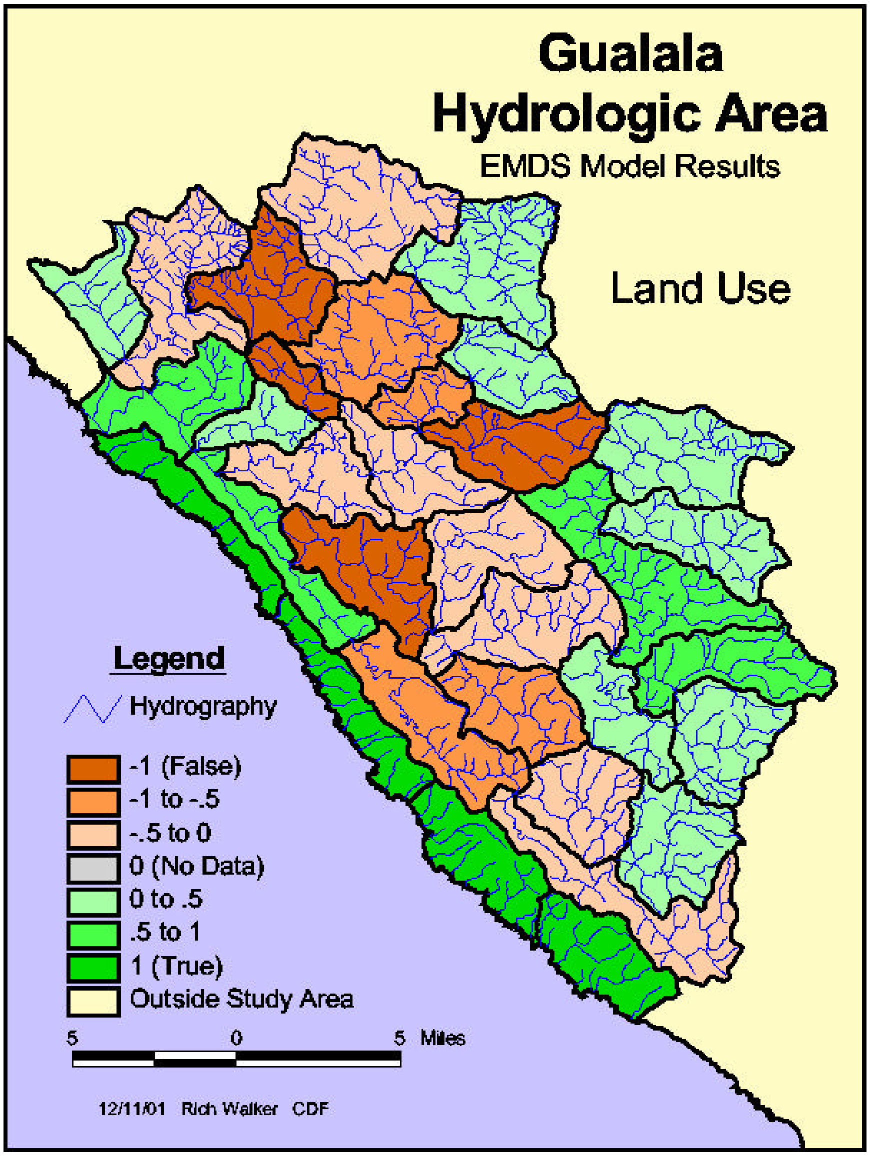
SLOPE STABILITY -

Proposition:

The natural slope stability in the Planning Watershed is suitable for sustaining healthy populations of native anadromous salmonids

Percentage of the planning watershed with significant erosion hazard. Potential unstable slopes are currently defined using SHALSTAB classes (q/T ratio), where log(q/T) <= -2.8.

<u>Break Points:</u> 12% low, 18% high
<u>Units</u>: area/area (%)



LAND USE –

Proposition:

Current and historic land use in the Planning Watershed are suitable for sustaining healthy populations of native anadromous salmonids

Percentages of the land area of the watershed are split up by potential slope stability (stable vs. unstable) and weighted by intensity (f(time since occurrence, activity)).

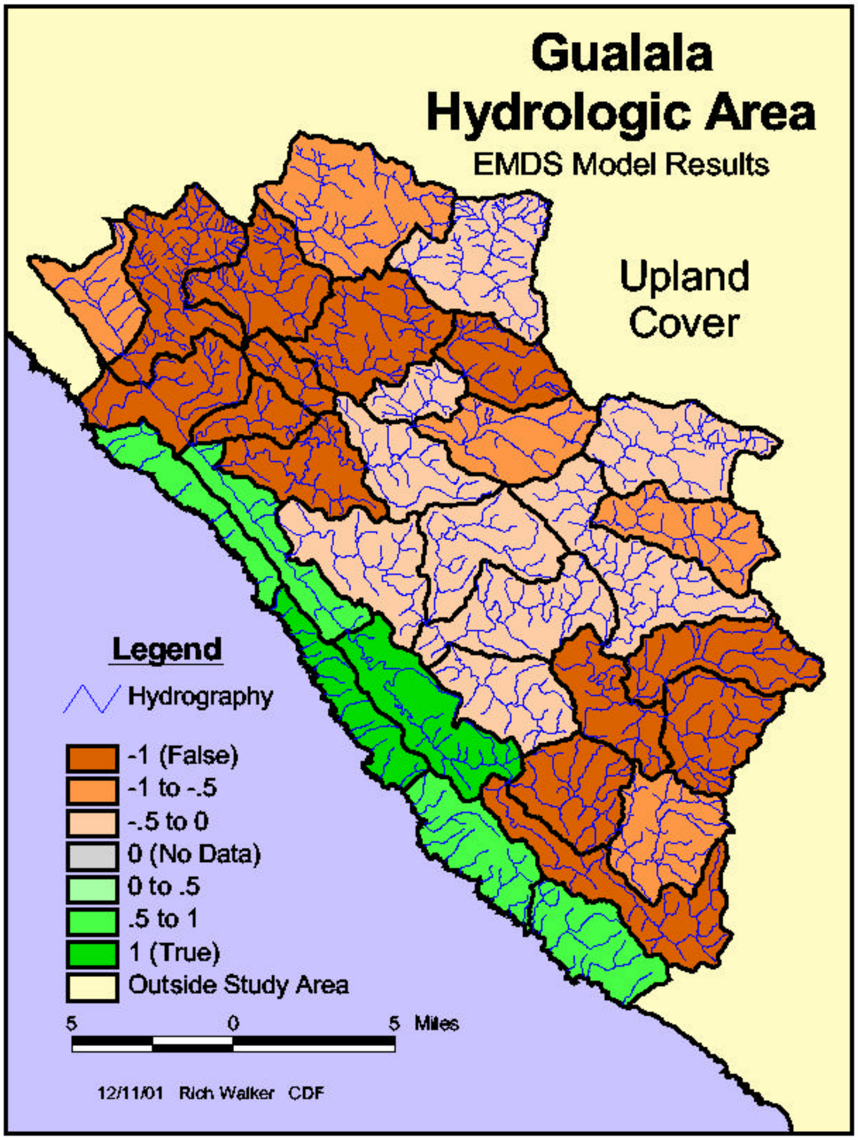
INTENSIVE – current permanent high density roads and buildings and row crop cultivation

TIMBER HARVEST – tractor logged and yarded, according to era:

- Last two years
- 1990 through 1999
- 1973 through 1989
- 1945 through 1972
- Prior to 1945

EXTENSIVE – current livestock use

Truth values were determined by fitting normal distribution to planning watershed land use values, then mapping 0th percentile to +1 (true) and 100th percentile to –1 (false).



UPLAND COVER –

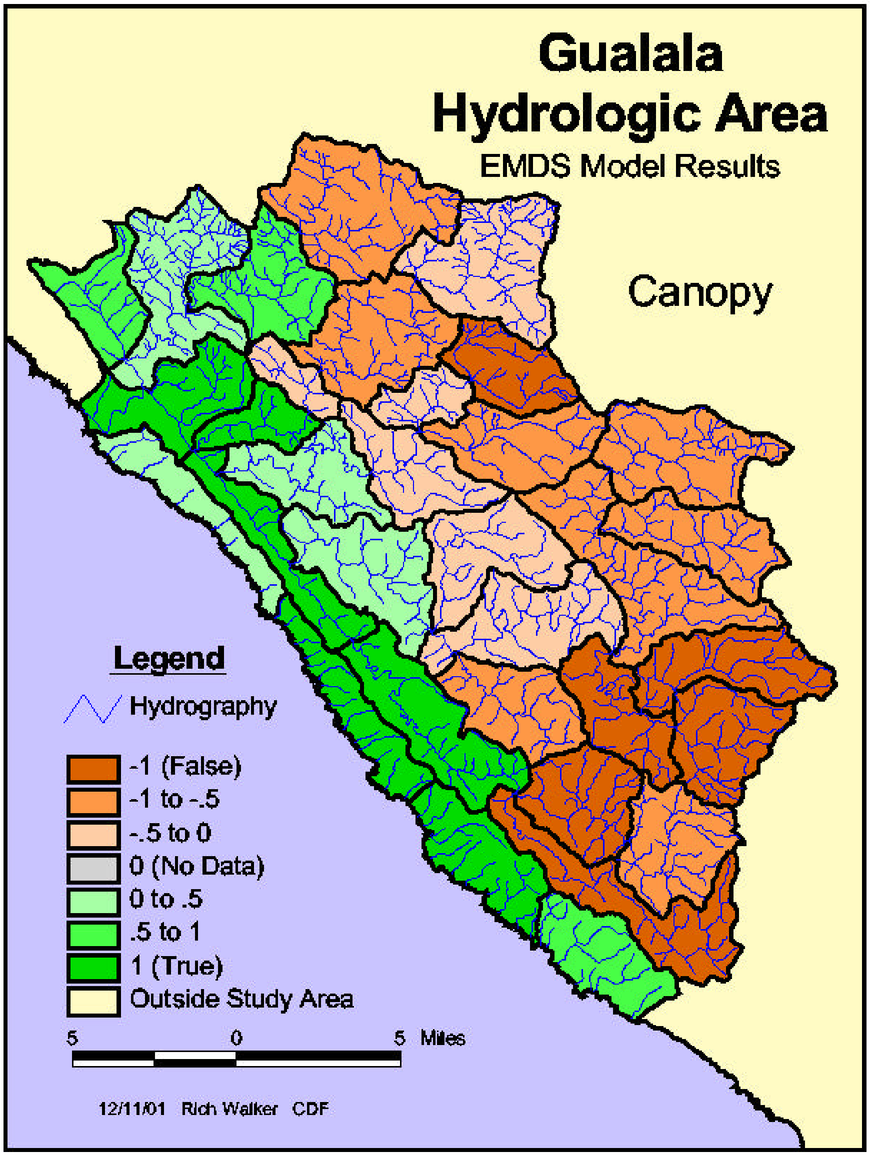
Proposition:

The condition of the natural vegetation in the upland of the Planning Watershed is suitable for sustaining healthy populations of native anadromous salmonids

Evaluated from:

CANOPY – percent of vegetation within pre-EuroAmerican settlement range of variation

SERAL OPENINGS – percent of area in vegetation <= 10 years since last stand-replacing disturbance



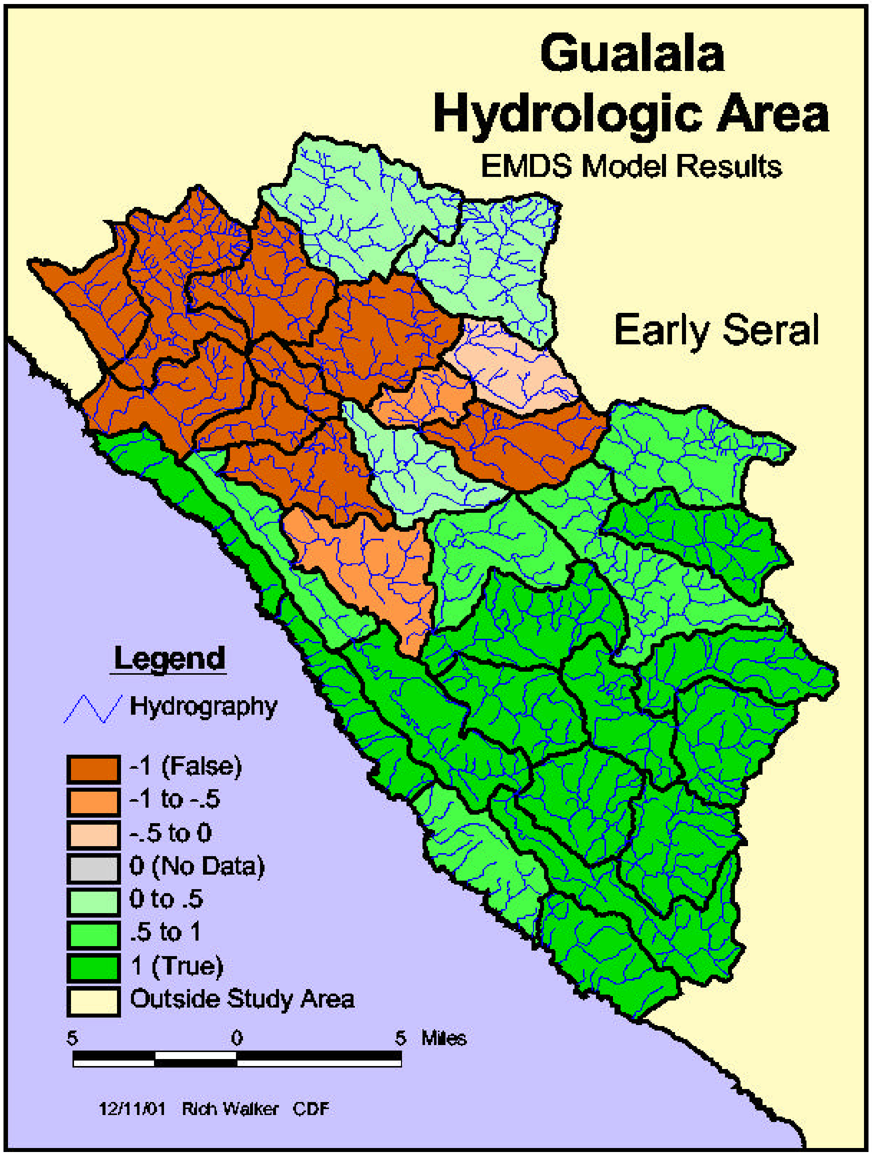
CANOPY –

Proposition:

The condition of the vegetation canopy in the Planning Watershed is suitable for sustaining healthy populations of native anadromous salmonids

Evaluated from percentage of vegetation within pre-EuroAmerican range of variation, using total area in size classes with dbh >= 24".

Break Points: 30% low, 75% high
Units: area/area (%)



EARLY SERAL –

Proposition:

The amount of the early seral vegetation in the upland of the Planning Watershed is suitable for sustaining healthy populations of native anadromous salmonids

Evaluated from the percentage of area in vegetation <= 10 years since last stand-replacing disturbance

Break Points: 10% low, 30% high
Units: area/area (%)

Model Needs

- Compare initial model results with ground reality and expert opinion; revise.
- Reviews of model architecture, possible revisions
- Refinement of basis for dependency curve break points
- Use of “Reference” watersheds to establish break points
- Possible incorporation of other models (e.g., SEDMODL)
- Methods for collecting and processing data to feed the model
- Model Validation - Sensitivity Analysis

APPENDIX 11

NORTH FORK ASSESSMENT FINDINGS AND DETAILS

Fisheries surveys conducted during this project in the North Fork sub-basin (14.7% of watershed) did not observe coho presence. While coho have been observed in the basin historically, the last observation of coho in the North Fork basin was 1998. The 2001 DGF NCWAP electroshoking surveys did not find coho anywhere in the sub-basin. Pat will rewrite this section.

Steelhead one year and older have declined or were not observed in the larger tributaries where sampled. Larger and older age steelhead require deep pools for rearing. Consequently deep pools are indicative of more favorable habitat conditions overall.

Little North Fork

McNeil samples in LNFG for percent fines <0.85 mm taken at four sites from 1992-1997 ranges from 11-28%. .Of the 20 samples collected at those sites for that period, five were below the TMDL maximum target of 14%.9 (WQ NCWAP).
Median particle size for samples from 1997-2001 ranged from 14-64 mm. Of the total of 24 samples collected at three sites, 11 were above the minimum 37mm target for the Garcia TMDL. (WQ NCWAP).
MWATs (Maximum Average Weekly Temperatures) range from 14-15 C, seasonal maxima from 15-17 C. .Suggested "fully supportive range" is 10-16 C and lethal is proposed at 24 C (WQ NCWAP).
Thirty-two (LNF2) and eighteen (LNF3) young-of-the-year coho were observed in 1998 (GRI, 2001).
Steelhead 1+ decreased from 285 to 148 from 1999-2001 (GRI, 2001).(DFG NCWAP)
The LNF was stocked with 45,280 juvenile coho from the Mad River Hatchery between 1995 –98. Carcass surveys were conducted in 1999-2000 no presence of returning spawning adults (DFG, 2000 F-51-R-13). .(DFG NCWAP)
During a 1964 stream survey, DFG biologist Charlie Parker noted: Steelhead, coho and roach observed. Ninety-five percent game fish (steelhead and coho), remaining were roach fish. Coho and steelhead juveniles estimated at 50/ 100 ft concluded that 80% of the length is favorable habitat. Maximum pool depth was 5 ft. Sand and silt consisted of 30% substrate. The Little North Fork is an important steelhead and silver salmon (coho) spawning and nursery tributary. Silt from past logging might limit egg hatching, but present natural propagation appears good. Recommendations included: Removal of slash, debris and log jams to improve fish passage and stream conditions. Possible planting of coho to establish a better run. .(DFG NCWAP)
Electrofishing in November 1990 showed that both lower and upper Little NF Gualala had a fish community dominated by steelhead young-of-the-year with sculpin and ammocete larvae present at the lower site (DFG, 1990). (DFG NCWAP)
Electrofishing in November 1999 showed that both lower and upper Little NF Gualala had a fish community dominated by young-of-the-year steelhead with steelhead 1+, 2+ and sculpin present but in low numbers (DFG, 1999). .(DFG NCWAP)
Steelhead young-of-the-year and 1+ were observed by the 2001 NCWAP field crew. Channel types were F4, B4, and B3. .(DFG NCWAP)
1992- CDF, WQ, DG&G indicate concern for higher level of harvesting within LNFG, and NF GRI. As indicated by WQ (00-101), 60% of the planning watershed has been harvested in the last 10 years mostly by even-aged management silviculture (93%, vs. 7% selection logging). .(DFG NCWAP)

Doty Creek

Percent fines <0.85 mm sampled at one site from 1993-1997 ranged from 11-17%, one observation below the TMDL maximum target of 14%. There were no particle size data available.(WQ NCWAP).
MWATs from 1994 and 1998 near the mouth of Doty Creek were 13 C and 14 C, respectively, within the "fully supportive range" of 10-16 C. Seasonal maxima were 14 and 15 ,respectively, below the proposed lethal limit of 24 C (WQ NCWAP).
Electrofishing in September 1986 showed that the Dry Creek had a fish community dominated by steelhead with no other species present. Yearling steelhead and two year old fish were both represented in the sample. (DFG, 1986) (DFG NCWAP).

The upper reaches of Doty Ck. were logged during the early 1960s as part of a large area-wide block clearance project in the Garcia watershed. The lower reaches were entirely logged by the late 1960s. Located in steep, deeply incised terrain, the haul road followed Doty Ck. adjacent to the stream channel (CDF NCWAP). .
Log Cabin Creek
Habitat Inventory was conducted in August 2001. Fish were not observed by the field crew. Channel type was a B4. Table 8 data is available at NCWAP Fortuna office (DFG NCWAP).

Central North Fork
Slightly less than 50% of the total of 68 data points collected at 12 sites throughout the middle and lower basin are at or above the Garcia TMDL 37 mm mimimum. Temporal trends were obvious at one site in Dry Creek and one in the Little North Fork. Over a three year period the Dry Creek site experienced an increase in D_{50} from 31 to 45 to 62 mm, indicating movement of finer sediments out of the area. (graphic WQ-1) (WQ NCWAP)
All the MWAT values in the North Fork are above the suggested "fully supportive" range of 50-60 F (10-16 C). From the upper-most station to the mouth of the North Fork the maximum MWAT for the period of record (1994-2001) declines from 72 F (22 C) to 64 F (18 C) below Robinson Creek (includes inflow from Dry Cr and McGann Gl), warming again to 65 F (19 C) just upstream of the Little North Fork, and dropping to 64 F (18) at the mouth below the inflow from the Little North Fork (graphic WQ-2). (WQ NCWAP)
McNeal samples at eight sites were sampled a total 35 times from 1992-1997. The range of mean fines <0.85mm for those 35 observations range from 11-28%, with 20% falling below the 14% TMDL maximum (WQ NCWAP). .
In the lower North Fork, fisheries log structures have been aggraded by 4 to 6 ft.
A lateral haul road was built in the late 1950s across a steep inner gorge ravine leading directly down to the North Fork about one quarter upstream and north of the confluence with Stewart Ck. The road then crossed the North Fork by a fjord graveled crossing to a large instream landing on the east bank of the River. The entire switchback turn across the inner gorge ravine collapsed into the river onto the instream landing by 1963, creating a gap in the road in excess of 300 ft. long (CDF NCWAP).
Main haul road follows the North Fork along the sideslope contour upslope, and in some areas adjacent to the stream channel. GRI sued over use of this road. Subsequently, 1.5 miles of this road abandoned along mid watershed location. Additional 2 miles decommissioned by CDF recommendation between the North Fork and Yellowhound Ridge.

Dry Creek
MWATs in Dry Ck. at four sites from 1994 to 2001 range from 15 to 18C. Seasonal maxima ranged from 16 to 21C (WQ NCWAP).
GRI Dry Ck McNeal Data 16.5 (95), 14.7 (96) 11.6 (97) indicating upper range within USF&WS Matrix 11 to 16%.
Over a three year period a Dry Creek site experienced an increase in D_{50} from 31 to 45 to 62 mm, indicating movement of finer sediments out of the area. (graphic WQ-1) (WQ NCWAP)
NMFS reports 57% of the Dry Ck. planning watershed subject to timber harvest operations during the last 10 years (00-101).
The lower reaches were logged during the early 1950s. The middle to higher reaches were entirely logged during the later 1960s after the 1964 flood. Due to the deeply dissected V-shaped valleys, the main haul roads were built directly adjacent to the stream channel. Numerous landing were built onto or adjacent to Class I watercourses (See Logging Impacts Map).
Sixteen young-of-the-year coho were last observed in 1998 (GRI, 2001). Electrofishing in July 1994 showed that the Dry Creek had a fish community dominated by steelhead with no coho present, with a large number of stickleback. Electrofishing in September 1986 showed that the Dry Creek had a fish community dominated by roach with steelhead the second most abundant species. Yearling steelhead represented about a tenth of the sample (DFG 1994). Steelhead young-of-the-year were observed by the 2001 DFG NCWAP field crew. Channel types of B4 and B1 were recorded during Habitat Inventory was conducted in August, 2001.

Robinson Creek
MWATs in Robinson Creek at five sites from 1994 to 2001 range from 14 to 16 C, seasonal maxima from 15-22 C (WQ NCWAP) . Water T in lower reaches of Robinson Ck. averaged over 65F (98-147).
GRI Robinson Ck. McNeil Data 15.2(95), 18.1(96), 17.9(97), indicating higher and slightly in excess of USF&WS Matrix 11 to 16%..

Tractor logged in the late 1960s. The haul road followed Robinson Creek. in the central reaches. There are several in stream landings adjacent to the main channel (CDF NCWAP).
Twelve young-of-the-year coho were last reported in 1998 (GRI, 2001). Steelhead young-of-the-year and 1+ were observed by the DFG NCWAP field crew. Channel type of B4 was recorded. Steelhead 1+ decreased from 422 to 13 from 2000-2001 (DFG NCWAP).

McGann Gulch

Tractor logged in the late 1960s. Large landing in the Gulch flushed out. Upper reaches have scoured out leaving the sediment to settle out in the lower reaches. Due the sediment loading, McGann Gulch flows underneath the gravel at the base of the Gulch, upstream of the NF. Or dries up, stranding steelhead trout (CDF NCWAP).
McNeil sampling for fines <0.85mm at the base of the gulch: 19 (95), 27(96), 19 (97). These are in excess of USF&WS Matrix standards, and exceed the TMDL target maximum of 14% (WQ NCWAP).
MWATs for two stations from 1995-1997 ranged from 14-16 C, seasonal maxima from 16-21 C (WQ NCWAP).
Steelhead young-of-the-year observed by the DFG 2001 NCWAP field crew. The survey was terminated after 67 feet to lack of water flow.

Stewart Creek.

The Area was tractor logged during the middle to late 1960s. Extreme sedimentation and accumulations of organic debris was deposited in stream channels by tractor skidding, and landing/ road construction in or near watercourses, devoid of erosion control measures (THP 97-171). Tractors had operated on slopes in excess of 65%. Older skid trails lead to in WLPZ landings. Lack of shade in many areas. A haul road was located within the creek bed or adjacent to Steward Ck,. This road has not been used since 1989.
A large waterfall blocks passage of anadromous fisheries at the confluence of the North Fk. Gualala River and Stewart Ck.
Bear Ck. area extensively harvested since the 1960s. Heavy sedimentation, logs, and debris jams are still present, especially in Class I watercourses. Some past damages are still contributing sediment to stream system. There is a moderate amount of LWD in Class IIs. Now, there is greater than 70% shade canopy cover on lower Stewart Ck. (97-072 CFL).

Billings Creek

A larger tract of Douglas-fir in the highest reaches was logged by 1964 with no erosion controil facilities installed prior to December 1964 flood event (CDF NCWAP).

APPENDIX 12

ROCKPILE CREEK ASSESSMENT FINDINGS AND DETAILS

Central Rockpile Ck.

- By the early 1960s, the main haul road followed directly along the central reaches of Rockpile Ck. Remnants of road and landings in Rockpile Ck. continue to contribute sediment during peak flows. Shade limited along Rockpile Ck due to large amounts of road segments and landings directly in or adjacent to upper reaches of Rockpile Ck (THP 97-510 CFL) from 30 yrs ago.
- Skidding and hauling in watercourses during 1950s, 60s, were noted in central and upper reaches of Rockpile watershed. High sedimentation and accumulation of debris found in channel. Downcutting and subsequent downstream aggregations noted. Conditions described in a stage of recovery as stream flow continues to flush sediment and organic material downstream (CFL 97-341, 97-345). In very steep areas, Class II and III watercourses were not used as skid trails.
- In the 1974 fisheries survey, downstream migrant traps showed that wild steelhead were the most numerous species captured.. By 2001, there was a decrease in steelhead counts from 153 to 48 between 1998 to 2001 at a lower monitoring station (GRI, 2001).

Mid summer CFL Stream Ts have been monitored daily since 1997 throughout middle and upper reaches of Rockpile Ck. (1) one mile downstream of Horsethief Ck. confluence, (2) upstream of Horsethief Ck. confluence, and (3) Upper Rockpile Ck, Upper South Fork. Stream temperatures exceed 20C for intermittent periods, and occasionally in excess of 20C everyday for more than two weeks. A Reeves criterion attributes water temperature impairment for Coho if stream temperatures exceed 68F for more than two weeks. CFL finds the Reeve criterion to be exceeded along the mainstem of Rockpile Ck "for brief intervals, throughout the sampling period".
Temperatures are higher in downstream reaches, compared to upstream reaches in the CFL ownership of Rockpile Ck. watershed.
CFL no harvest WLPZs are routinely stipulated for all THPs along Rockpile Ck. and Class II tributaries to mitigate temperature impairment throughout the watershed. Canopy cover is "lacking in most areas along Rockpile Ck", mid to higher reaches (CFL 97-475).
Red Rock Ck.
Logged in 1959-1960. The main haul road was built along Red Rock Ck. for nearly the entire length of the Class I watercourse. Numerous in stream landings lined Red Rock Creek (CDF NCWAP).
In the mid 1990s, extensive streambank rehabilitation work was carried out by J. Monchke.

Upper Rockpile Ck.

- Seven seed tree overstory removal/ dispersed harvest THPs dated 1997-98 exceeded 60% of the 2700 acre Brandt tract within the Upper Rockpile Ck. WAA. These plans directed road repair work throughout the road network area wide. This included (1) repair of two watercourse diversions (CFL 97-371), (2) removal of a long section of seasonal road across Rockpile Ck. (legacy road), and (3) repair of two other watercourse diversions, (CFL 98-091). These THPs stipulated temporary watercourse road crossing specifications as the dominant use among seasonal road laterals. This requires abandonment of road crossing structures with road approaches bladed back to reestablish original streambank configuration and exposed soils treated with grass seed and mulch.

APPENDIX 13

BUCKEYE CREEK ASSESSMENT FINDINGS AND DETAILS

. Three sites were sampled for median particle size (D_{50}) by Gualala Redwoods, Inc. in the lower three miles from 1997-2000 for a total of 15 measurements. One of those data points is above the 37 mm minimum Garcia TMDL target. There are no apparent spatial or temporal relationships.(WQ NCWAP)

The watershed is similar to Rockpile Creek in vegetation distribution (little canopy in the upper watershed) and as in Rockpile Creek, stream temperatures are warm in the mainstem, exceeding the fully supportive range and approaching the lethal range in some cases. Four sites monitored from 1994-2001 yielded 15 MWAT values ranging from 64-70 F (18-21 C), all above the "fully supportive range" of 50-60 F (10-16 C) (Graphic WQ-4). Seasonal maxima for the mainstem ranged from 70-75 F (21-24 C).

Little Creek
The Little Ck. basin was logged during the late 1950s. The main haul road followed the stream channel throughout the entire Class I portion of Little Ck. Numerous in stream landings were concentrated in this tributary watershed.(CDF NCWAP).
Lower to Mid Reaches Buckeye, CFL, the main seasonal road followed along the streambed or adjacent to Buckeye Ck. (See Logging Impacts Map , CDF NCWAP). This road undercut steep ground between Stanly and Brushy Ridges causing landslides into Buckeye Ck. This road section has been abandoned by a rock slide and numerous washouts. Little River tributary also similarly tractor logged. Tractor logging occurred on slopes in excess of 65% (97-036, CFL).

Francini Creek
Coho were know to spawn and rear in Franchini Creek (Cox, 1994). In a 1995 survey, electrofishing showed that Franchini Creek had a fish community dominated by steelhead with no other fish present. Two year old steelhead were absent (DFG, 1995). Coho were not observed in the lower, middle and upper reaches during electrofishing conducted in October, 2001 (DFG NCWAP). The lower reach was dominated by steelhead young-of-the-year and pacific giant salamanders with steelhead 1+ and yellow-legged frogs present. The middle reach was dominated by steelhead 1+ with yellow-legged frogs, steelhead young-of-the-year and salamader larvae present. The upper reach was dominated by steelhead1+, salamander larvae, steelhead young-of-the-year and yellow-legged frogs present (DFG NCWAP, 2001).
The entire tributary basin was logged 1959-1960. The main seasonal road followed in and adjacent to the stream channel. Numerous debris slide failures have been noted along the main WLPZ road in 1961 and 1965 photos, as Francini Ck. undermined the road (CDF NCWAP).
WQ stream surveys of Francini Ck find fine sediment almost completely burying cobble (WQ TMDL, 2001).
The Francini Ck. watershed was burned through during the 1950s. Subsequent salvage logging used in WLPZ roads and in stream landings (97-034, CFL).

Grasshopper Creek.
The main haul road, now abandoned, followed the stream channel of Grasshopper Ck. leading west to the Buckeye Ck. Rd. No culverts were used and the road was abandoned with no stabilization measures applied. Logs were skidded downhill, often directly in watercourses. No waterbars were built or stream crossings ditched out. Stream channels now contain large amounts of stored sediment behind jams of large woody debris. The channel continues to downcut to pre-logging level. (93-328)
Logged just prior to 1964 flood. During the storm, logs and slash floated down to a central in stream landing complex at the confluence of the north and south forks. The wood debris blocked the low road crossing, causing Grasshoper Ck. to divert across the south road approach, incising this down, and then undermining the west road approach, causing a broad debris slide into the creek. Further downstream, Grasshopper Ck. diverted onto the road at two fjord road crossings, causing sections of the road to fall into the creek (CDF NCWAP).
Fine sedimentation in pools relative to volume of fine sediment and water (V*) shows 59% pool volume filled with fine sediment, rating comparatively high (Knopp, 1992).

Grasshopper Creek enters a steep, narrow canyon before its confluence with Buckeye Creek. The canyon walls are mapped as debris slide slopes; although, no landslides were found in the photos examined. In fact landsliding is somewhat rare in the Grasshopper Creek basin (DMG NCWAP)..

Middle Reaches Buckeye Creek.

Subject to harvest removals and conversion to pastureland, including burning, during the 1950s, 1960s. High sedimentation and accumulation of debris found in channel. Downcutting and subsequent downstream aggregations noted. Uncontrolled installation of fills, failure to remove fills, and lack of erosion control facilities has caused several landslides and locally severe erosion. Soda Springs Cks. are also Class I watercourses. PHI describes LWD as common in smaller streams. Existing haul road in and out of Buckeye Ck. Major road repairs to correct on site sediment sources (97-070 and 442, CFL).

Water T, 16 to 19C, east and west tributaries Buckeye Ck. exceed optimum for Coho south of Bear ridge, Kelly Rd (Flat Ridge Ck. Planning Watershed). Much of the streams are forested with sapling sized conifers/ hardwoods. Extensive grassland areas with more open riparian zones from older intent to conversion, now abandoned. Watercourse areas were heavily cut out during late 1950s tractor operations. Stream diversion repairs noted. New road construction to relocate road segments to ridgeline (CFL 97-227).

Stream diversion realignments of Class II watercourses specified to repair deep gully erosion down roads and skid trails. This was required on an 800 acre plan upslope of Buckeye Ck as a Class I watercourse. A no-harvest provision within the Class I " follows a four year standard of added protection for Buckeye Ck. ..The landowners and agencies agree that Buckeye Ck. has a temperature problem and needs additional time to develop the shade and pools to improve fish habitat". The pre-1973 practice to build roads and landing in or near streams was widspread and led to massive degredation of the stream system. They were choked with sediment and large woody debris. Stream side vegetation was eliminated and shade canopy was greatly reduced." (S Smith, CDF). Past cattle grazing in this area after 1960s era harvest entries prevented timely overstory reestablishment of canopy cover over fish bearing watercourses (CFL 97-442). .

Electrofishing showed that a Buckeye Creek tributary had a fish community dominated by roach with steelhead also present. Two year old steelhead were absent (DFG NCWAP). .

Soda Springs Creek.

Electrofishing showed that Soda Springs Creek, tributary of Buckeye Creek, had a fish community dominated by steelhead with yearling and two year old steelhead present (DFG, 1995).

North Fork Buckeye

Steelhead and Coho reported in North Fork Buckeye in 1964. A 1982 survey found pools at 25-40%. Steelhead comprised 40% of fish, among high temps, algae blooms, and lack of cover. A 1995 survey shows 20% pools. No harvest WLPZ measures implemented to mitigate streamshade deficiencies from pre 1973 era. Historically, area occupied by Douglas-fir. Area tractor logged during the 1950s. Some areas entered lightly due to terrain and poor quality of the timber stand. Uncontrolled installation of fills, failure to remove fills, and lack of erosion control facilities has caused several landslides and locally severe erosion. Correction of on-site sediment sources with THPs. Watercourse diversion repairs noted under THP 1-97-084. Historical intent to permanent conversion to grazing lands with the Howlett Ranch. Older haul road located adjacent to NF Buckeye Ck. A diverted Class II watercourse triggered a large translational/ rotational slide and "massive erosion" (DMG Report, M. Manson CFL 97-084). The plan required redirection of the watercourse to natural channel by excavator work. Class II watercourse tractor crossings left in place from the 1950s have washed through leaving vertical cuts over 6 ft. down.

Roy Creek (higher Buckeye watershed)

Most areas were tractor logged during late 1950s to 1960s. Logging was accompanied by attempted conversion to rangeland. Site recon. during several PHIs documents tractor skidding down all slopes irregardless of steepness, to roads and landings located in or adjacent to watercourses. The lack of erosion control caused deep gullying down skid trails discharging into watercourses. Large quantities of soil and debris was placed or washed into watercourses. Debris slides above and below roads are common and frequent. Maintenance of a passable road surface involves clearing of slide debris from the roads and installing infrequent ditch relief culverts. Recent timber

harvest activity since 1973 repaired and improved drainage conditions where operations occurred. (M. Jameson, CDF Audit Forester, 1995).
Roy Ck., in the lower 2 miles above the confluence with Osser Ck., is described in poor condition. High bedloads of sediment line the channel, partially filling pools. Size of pools is reduced by sediment. LWD is not abundant. Upper tributary of N.F.Buckeye Ck. is wide and shallow with low amounts of LWD. Most of the large hardwood and conifers that once lined the streambanks have been cut and the area converted to grass, creating high stream temperatures. (M. Jameson, 95-114). A pool at 2:00 P.M. 8/19/94 measured 75F, a second at 72F. With the recent elimination of grazing activity, conifers have begun to reinvade pastured areas
The lower kilometer of Roy Creek crosses the Tombs Creek Fault Zone and is impacted by a large active earthflow complex that makes up the NW hillside above the creek. The earthflow formed in the Central Belt Formation which is on the NE side of the Tombs Creek Fault Zone. (the earthflow is a grassy area, probably never offered LWD

Osser Creek (higher Buckeye watershed)
Logged by late 1950s. Many areas in Osser Ck. subwatershed were first harvested by a diameter limit cut. Tractor operations used some creek channels as skid trails, building landings in or near watercourses. Sediment pushed into creeks from historical operations is still present, and slowly flushing during peak flow events (CFL 99-145).
Field recon during several PHIs describes Osser Ck subject to heavy deposits of soil and debris (CFL 97-070 and CFL 95-114). Size of pools reduced substantially by filling with fine sediments. An active earthflow impinges on the creek in areas probably contributing fines but on-site evaluation is needed to verify. Most channel overstory cover removed by historical logging and conversion to pastureland. Current shade on Osser Ck. is estimated at 80% in upper reaches, and increasingly lower in downstream reaches. Current condition is described in a stage of recovery, requiring many decades for fine materials to flush downstream during high flow events. Background levels of sedimentation are generally high but not specifically known and should be considered in evaluating recovery from land use disturbance. Streamside shading will similarly require several decades to recover with conifer ingrowth after cessation of grazing and conversion to pastureland. (M. Jameson, 95-114).
Electrofishing showed that Osser Creek had a fish community dominated by roach with steelhead also present. Two year old fish were absent. (DFG, 1995)(DFG NCWAP). .

Flatridge Creek
Electrofishing in showed that Flatridge Creek had a fish community dominated by roach with young-of-the-year steelhead also present. One and two-year-old steelhead were absent (DFG, 1995, DGF NCWAP).

APPENDIX 14

WHEATFIELD FORK ASSESSMENT FINDINGS AND DETAILS

Fuller Creek

- The Fuller Ck. sub-basin consists of steep, deeply incised terrain. Upper reaches are characterized by inner gorge ravines. In the lower reaches, there has been deep downcutting by Fuller Ck. between plateau areas of moderate to near level terrain upslope. The upper sub-basin including North and South Forks were mostly logged by between 1960 and 1964. The Lower reaches south of Fuller Mt. were logged during the mid to late 1950s (See Logging History Maps). Main haul roads were all built along the creek channel at the base of steep terrain. Large in stream landing complexes were built by filling the channel with wood debris chunks and topped with dirt. Skid trails were constructed in streams and draws, and surface flows were concentrated and diverted. The 1964 flood event caused massive erosion downcutting, slides, and washing of soil and debris into watercourses.
- Four large debris flows are apparent in the 1965 photos. These slides originate from areas that were severely disturbed by logging. By 1984 these slides are obscured by revegetation. Active landsliding is most abundant along the SF of Fuller. An unmaintained logging road parallels the creek on the north side. The road is generally 20-30' above the creek. The slopes are steep, large debris slides are very common. The road has been obliterated by debris slides. 1961 photos show minimal active slide movement prior to harvesting. The 1942 photos show dense mature wooded cover with no visibly active slides (W. Haydon, DMG). Similarly, the South Fork contained dense mature conifer cover, which was logged by 1964. To this day, sideslopes along the S.F. continue to discharge a variety of sediment in the creek. The roadbed is actually intercepting large volumes of sediment. Field inspection of two of the delivering debris slides revealed that the one consisted mainly of coarse gravel and the consisted mainly of crumbly shale that would readily decompose into fines. The streambed below these slides consisted of coarse gravel and cobbles and did not seem excessively sediment impacted (DMG NCWAP).
- In the North Fork, the main creek diverted onto the in-stream haul road during the 64 flood, causing an estimated one quarter mile section of the road to collapse into the creek (See Air Photo 2, CDF NCWAP).
- The 1964 storm surge smashed through two road crossing structures accessing a large in- stream landing complex in excess of two acres in size downstream of the NF/ SF confluence. Located at the base of a turn in the creek, peak flows cut through the landing creating a deep basin canyon on the discharge side (See Air Photo #1 CDF NCWAP). .
- By 1968, a massive debris slide breached two road spans contouring steep terrain in the South Fork. Starting from the Fuller Mt. Ridge, the slide mass rammed down onto the South Fork, creating a lake. This later breached, leaving a water-fall appearance in the channel (CDF NCWAP).
- The earliest documented fisheries survey in Fuller Ck. dates to summer, 1964. At this time, Rowell and Fox found the main stem Fuller Ck. (up to NF/SF) still supporting salmon and steelhead. Pools constituted 70% of the stream reach with a maximum pool depth of six ft. Fine sediment comprised 20% of the stream substrate. By 1971, Parke and Klamt found pools reduced to 40% of the reach, maximum pool depth at 4 ft., and silt and sand at 35%. Of total stream substrate.
- In 1964, Rowell found the North Fork still supporting salmon and steelhead but in rapid decline due to logging, reporting pools at 30% total reach, and 40% substrate consisting of sand and silt, deepest pools at 3 ft, and overstory canopy depletion by removal of riparian conifers. By 1971, Parke and Klamt found pools reduced to 25% of the stream reach of the NF, and maximum pool depth at 2 ft.
- In 1964, Rowell and Fox reported in the South Fork heavy sand deposits at 50% of the substrate among dense concentrations of jams, logging slash and debris. Pools had completely filled in with a maximum depth of 2 ft. and average depth of six inches. By 1971, Parke and Klamt reported some recovery in the SF to 15-20% favorable habitat by reach, maximum pool depth 2.5 ft., silt and sand comprising 50% of total substrate, but a water temperature of 78F. The 1964 flood may have flushed some of the logging debris downstream by 1971 since coho and steelhead counted at 100/100 ft. reach (P. Higgins compilation, 2001). .
- By 1996, Sotoyome reported the Main Stem Fuller comprised of 61% riffles and 39% pools, similar to the 1971 survey. In the NF, Sotoyome found pool frequency at 36% and maximum pool depth at 3 ft., and 68% shade canopy cover, indicating recovery from logging damage. In the SF, Sotoyome found pools had increased

to 35% reach and maximum depth at 4 ft. Only 37% of pools were greater than 2 ft. depth. Shade canopy cover measured at 59%. Cox (1989) found densities of steelhead juveniles at 53/100 ft. reach but a 1995 survey reported half this density (Cox, 1995). These factors indicate recovery, but slower compared to the NF (P. Higgins, 2001).

- Fuller Creek temperatures are warm, MWATs at five stations for 2000 and 2001 ranging from 59-66 F, and seasonal maxima ranging from 68-73 F. While most of the maxima at the Fuller Creek stations were below lethal, most of the MWATs were above the fully supportive range.
- In the lower sub-basin, Sullivan Ck.is noted as a current source of sediment to Fuller Ck. during peak flows (CFL 97-219). As a deeply incised canyon, the haul road was built directly up the creek. A major landing complex was built near the bottom of the canyon on the south bank of creek, due to the inability to put more landings in upstream because of the steep terrain. During the 1964 flood, Sullivan Ck. eroded down through this landing. At the confluence point with Fuller Ck, Sullivan Ck meandered back and forth among deeper and widened aggraded substrate (See Air Photo 6). The 1961 photo shows the original near lineal and narrower drainage pattern in this same area prior to 64 flood (see Air Photo 7). The 1995 Sotoyome survey describes Sullivan Ck. in mid-recovery at 23% pools but 16% of the streambed was dry from aggregation. Average depth of pools was 2 ft. but 38% of pools were greater than 3 ft. deep. Canopy had recovered to 89%.
- The Gualala Watershed Restoration Council coordinated large scale road abandonment and drainage upgrade work in the Fuller Ck. basin during the mid 1990s. Streambank rehabilitation work has been carried out by J. Monchke during this time.
  East and highest/ steeper reaches of the Fuller Ck. watershed more recently entered due to concentration of remnant stands left unreachable during the 1960s. Cable and sometimes helicoptor yarding methods most frequently used (CFL THP 97-365).
  Conversion of much of the area around Oak Ridge for grazing at NF Fuller, now in brush (THP 97-333). Trees originally removed for conversion to grazing, Timber industry in these areas increased harvesting in the 1950s, creating a mixed use.

<u>Tobacco Creek</u>

- Tobacco Ck. at main stem Wheatfield, Mendosoma FFS, Annapolis Rd., mid section of watershed 7/22/00 Water T 20C 800 .A.M., 6:00 P.M. <u>25C</u>, indicating temperature impairment.
- Main road built along Tobacco Ck. with series of landings in or adjacent to the main creek. The 1964 flood event incised each of these landings cutting deep vertical gorges and creating canyons on the discharge side (See Air Photo 32, CDF NCWAP).
- By 1964, harvest operations advanced east of the Tobacco Ck. area to the higher reaches of an adjacent larger order stream flowing down a ravine to Wheatfield Fk. The 1964 flood event triggered a long torrent slide all the way down the creek through a mature timbered tract discharging into Wheatfield Fk. By the late 1960s, a haul road was built over the torrent slide following the creek (CDF NCWAP). .

<u>Haupt Creek</u>

- First logged in the late 1800s to early 1900s with steam donkeys. Ben May logging Co. Lumber Co. was the first major landowner The lower portion of Haupt Ck. was logged during the late 1950s. (98-281, MRC). Most remaining areas upstream were logged by 1970.
- Coho were known to spawn and rear in Haupt Creek (Cox, 1994). The 1964 overall survey composition: steelhead, rainbow trout, stickleback, and a large population of roach. Abundance for steelhead fishes and rainbow trout- 25/100 ft. and roach 200/100 ft. Large amount of spawning and nursery areas are not being used because fish passage is hindered by barriers. Drying of stream in summer months could limit fisheries value, but due to the many pools, juveniles should survive. Haupt Creek could become a first class steelhead and coho producing stream (DFG, 1964)(DFG NCWAP).
- In 1964, Klamt and Pool describe the headwaters and lower reaches of Haupt Ck. “so aggraded from the previous logging that the stream flowed underground in places” Pools comprised 80% reach length, with maximum pool depth at 5 ft. Coho and steelhead equally abundant but at densities of 25/100 ft. Roach found at 200 per 100 ft. In 1970, Park and Klamt found that pools had declined to 60% stream reach, and maximum depth reduced to 3 ft. Coho salmon still noted in 1970 at densities of 25/ 100 ft., but only in the lower reaches. Steelhead had increased substantially to 500/ 100 ft in the lowest reach and 100/100 ft. further upstream.

Steelhead compete well in altered stream habitats (Higgins, 1995). The aggregation point causing subsurface stream flow in lower Haupt, had washed downstream by 1970.(P. Higgins Gualala Compilation, 2001).

- Coho was not observed in the middle reach during electrofishing conducted in October, 2001. The lower reach was dominated by steelhead young-of-the-year and roach, with sculpins, stickleback, steelhead 1+ and newts present (DFG, 2001). As noted in a 1964 stream report: Haupt Creek is polluted from siltation and slash from past logging operations (DFG NCWAP).
- Currently, the LP SYP describes the main channel of Haupt Ck. having relatively low structural diversity with long shallow stretches and only occasional pools. Heavy aggregation not indicated. Historically active landsliding has been limited to small (< 100' greatest dimension) events. Best ratings for spawning conditions of all tributaries to Wheatfield Ck (98-281, LP SYP). Currently, Coho are not found. Steelhead only (T. Wooster, F&G). Haupt Ck. is highly responsive to rainfall probably because of its steep narrow inner gorge (98-281 MRC). Major tributary Class II in lower south bank of Haupt, used as a skid trail prior to 1970, downslope of Tin Barn Rd.

North Fork Wheatfield (upstream from Toombs Creek)

- Downslope areas along the Main Stem N.F. Wheatfield, flanked by Bear and Gibson ridges, were tractor logged during the late 1950s. Upslope areas were logged by 1964. Tractor skid trails were excavated throughout deeply incised terrain along the N.F. No active slide areas are noted in 1942 photos. The 1964 photos show numerous steep inner channel debris slides along the N.F. among recently logged areas. During the 1964 flood, one watercourse diverted onto the haul road, discharging at the headwall of one the larger slides (See Air Photo 10). Another major watercourse diversion onto roads is noted in this area (See Air Photo 11, CDF NCWAP).
- Northeast corner of Wheatfield watershed logged 1991 thru 1997, most heavily roaded area. Remaining portion of this part of the watershed helicopter logged due to steep terrain . Ridge tops converted to orchards or vineyards.

Elk Creek

- Elk Creek, tributary to the higher reaches of N.F. Wheatfield, was used historically for livestock grazing known as the Tabor Ranch. Mixed conifer/ hardwood stand developed in response to clearing and burning operations with intent to convert to pastureland. Elk Ck. was heavily impacted by tractor operations in 1950s, 1960s. Upper segments of Elk Ck. were used as skid trails with instream landings at truck road crossings. Logging debris and soil placed in stream beds. Flushing of this material continues with peak flow events. Existing road adjacent to Class II abandoned with new road relocated to the ridgeline (93-436 CFL. Five steam diversions onto truckroads repaired (92-382). Streambank rehabilitation work directed by J. Monchke.

Toombs Creek

- Upper Wheatfield, Toombs Creek, timber harvested to convert to grazing land in larger areas of the subwatershed. Sedimentation and accumulation of organic debris in channels during original tractor logging during the late 1950s and 1960s (CFL 97-158). Conversions to pastureland have been the dominant form of historical use. Tractor skidding down watercourses removed overstory canopy cover with intent to maintain permanent conversion for grazing use.
- One channel type of B4 was electrofished and showed that roach dominated (134) with steelhead 1+ (25), steelhead young-of-the-year (18), stickleback (5), newt (5), and steelhead 2+ (2) present. A roach dominated community indicates impaired conditions (DFG NCWAP, 2001).

House Creek

- Coho were known to spawn and rear in House Creek (Cox, 1994). A 1965 survey found steelhead ranging from 75 to 125/ 100 ft. among near equal number of roach and stickleback along three sample reaches. No coho were reported in this 1965 survey. Pollution-Use by horses, cattle and sheep (DFG, 1965). A 1970 survey reported Coho at 25/ 100 ft. in the lowest sample reach. Steelhead –500+/100 ft. in lower sections and 100/100 ft. in upper section. Sheep in upper one mile of stream (DFG, 1970).
- The gate on a 4-5' high dam on house creek on Soper Wheeler property has been opened because the reservoir has been completely filled with bedload from upstream. Downstream of the dam the channel is incised to

bedrock, probably due to the depletion of bed and suspended loads. In a few areas along House Creek, remnant bedrock terraces –capped with cobble sized alluvium- are found above the channel (as much as 1-5-20' in one area)(DMG NCWAP).

- Downstream of the dam, House Creek, the bed changes dramatically from a shallow flat bottomed, fines-dominated condition to a bedrock terrace covered with cobbles coarse sands, and gravels. A large portion of the alluvium is out of the active channel. This terrace occurs approximately at the toe of a large active landslide. Some of the coarse material may have derived from the slide. The bedrock terrace may represent a localized uplift or tilting, perhaps due to deepseated forcing of the landslide against the bank. For example some slides move by rotational about a horizontal axis. So, in rotational slides, the toe area may become somewhat elevated. However; no attempt has been made to test these hypotheses Continued use by cattle has trampled the banks in some areas and may adversely contribute to the nutrient load –algae was noted to be common in pools in House Creek (DMG NCWAP). .
- In the lowest reaches of House Ck. near Wheatfield Fk., roads were built up several Class I tributary watercourses during the late 1950s throughout a larger timbered tract flanked by Skyline Ridge. Peak flows during the 1964 flood removed several sections of the road (See Air Photo 27)(CDF NCWAP).
- In the highest reaches of the House Ck. basin, upstream of the confluence with both Brink and Cedar Cks., Douglas-fir tracts on north facing slopes were entirely removed during the mid 1950s. Long sections of riparian areas were entirely cleared of all overstory canopy cover with intent for conversion to pastureland. Lack of erosion control facilities created gully erosion noted in 1965 photos (CDF NCWAP).
- By 2001, Coho were not observed in the lower, middle and upper reaches during electrofishing conducted in October, 2001 (DF&G NCWAP). The lower reach was dominated by roach and stickleback with ammocete larvae, yellow-legged frogs, steelhead young-of-the-year and one 1+, crayfish and sculpin present. A roach dominated community indicates impaired conditions. The middle reach was heavily dominated by stickleback with roach, ammocete larvae, bullfrog larvae and steelhead young-of-the-year present. Steelhead 1+ were not observed. The upper reach was dominated by roach, with ammocete larvae, steelhead1+, newts, yellow-legged frogs, and a western toad present. Steelhead young-of-the-year were not observed. Anchor worms were observed on steelhead inhabiting reaches 2 and 3. E-fishing crew noted excess sediment in all low velocity areas, cows in creek, extensive pig activity, lack of large woody debris and over 50 lamprey redds (DFG NCWAP, 2001).

Pepperwood Ck. (Tributary to House Ck.)

- In the headwaters of Pepperwood (Oak Mountain) landsliding is especially abundant, active, and complex. Downstream in map sections 15 and 16 the stream cuts into a broad alluvial terrace that is almost 900 feet wide at the confluence with Jim Creek. Much of terrace material is outside of the active channel. This terrace and those along House Creek seem to be isolated remnants of former drainage patterns and may even be related to isolated fluvial deposits along the crest of Kings Ridge about a mile to the south and elsewhere in the uplift. And so it is uncertain whether the coarse and locally abundant alluvial deposits and bedload result solely from sediment transport within the current stream network from the abundant landslides in the headwaters or from a former system that has been deranged by faulting and uplift and no longer operates (DMG NCWAP).
- Other abandoned areas have regenerated with young conifer/ hardwood overstory. Numerous active earthflows occur along large portions of channels, even more abundant are dormant earthflows that potentially could be reactivated. In each of these landslide-impacted reaches, the channels widen. (DMG NCWAP).
- One channel type of F4 was electrofished and showed that roach dominated (80) with steelhead young-of-the-year (28), steelhead 1+ (23), stickleback (6),unidentified tapole (6) and steelhead 2+ (2), and one ammocetes and crayfish present (DFG NCWAP).
- Vegetation has been shaped by repeated fires. Area entirely burned over in 1955, with other subsequent fires to present. Conversions to pastureland have been the dominant form of historical use. Tractor skidding down watercourses removed overstory canopy cover with intent to maintain permanent conversion for grazing use. In many areas, soil compaction by heavy cattle access has prevented timely reestablishment of overstory canopy cover of watercourses with recent abandonment of agricultural use (CDF NCWAP).

APPENDIX 15

SOUTH FORK AND LOWER MAINSTEM GUALALA ASSESSMENT FINDINGS AND DETAILS

Marshall Creek.

- Marshall Creek drains an area where the Central and Coastal Belts of the Franciscan Formation have been complexly faulted and shuffled. Large active earthflows within the Central Belt rocks are common along most the length of Marshall. Small (< 100 feet in greatest dimension) historically active slides that delivered into Marshall Creek are especially abundant in the lower reaches where the stream crosses the weak rocks of the Central Belt Franciscan Formation (DMG NCWAP).
- Conversions to pastureland have been the dominant form of historical use. Major portions of riparian areas were converted to pastureland (See Air Photos 30 and 31). A loop conversion project removed all downslope conifered areas eliminating the riparian zone throughout Wild Cattle Canyon, extending east in an arc connecting Palmer Canyon, during the later 1950s (CDF NCWAP). Sheep noted grazing in riparian zone in Palmer Canyon during a 1981 survey. A 2001 DFG NCWAP survey in Palmer Canyon found 35% pools. Substrate consisted of 47% cobble/ gravel, 30% boulders, and 12% silt and sand.
- A 1964 survey in Marshall Ck. from the mouth with the SF to 13 miles upstream found Coho present at 30/ 100 ft. reach and steelhead numbering 100/100 ft. length. Gravel suitable for spawning comprised 60% substrate. Pools comprised 50% stream reach with a maximum depth of 5 ft. Maximum water temperature measured 69F (P. Higgins Gualala Compilation).
- A 2001 DFG NCWAP survey reach of Marshall Ck. found 50% pools at 1.2 ft. average depth, to 50% riffles. Gravels measured to 60% total substrate, silt and sand 10%, and boulders 10%.

McKenzie Creek

- The McKenzie drains Kings Ridge, which is a small portion of a 4kmx8km area that was uplifted no later than the last 5 million years as a result of compression along the San Andreas Fault. See the geology report for explanation. Within this uplift, the upper two forks of McKenzie flow through parallel steep canyons flanked by debris slide slopes where the channels widen. The lower McKenzie narrows and flows southward across the uplift and joins Marshall.
- Numerous active earthflows occur along large portions of channels, even more abundant are dormant earthflows that potentially could be reactivated. In each of these landslide-impacted reaches, the channels widen (DMG NCWAP).
- A continuous wide belt of mature Douglas-fir occupied the lower and central reaches of McKenzie Ck. extending from the confluence with Marshall Ck. to Devils Rib Ridge. Parker and Pool (1964) surveyed this tributary to Marshall Ck. finding optimal steelhead habitat. Fine sediment only comprised 10% substrate with pools at 60% habitat by reach. Steelhead densities were estimated at 50/ 100 ft. length, and ratio of steelhead to roach were estimated at 95:5 (P. Higgins Gualala Compilation, 2001).
- The Upper McKenzie was then logged after the 1964 fisheries survey. The main haul road followed the stream channel. Numerous in stream landings are located throughout the basin (see Logging Impacts Map). The riparian zone was cleared of all overstory vegetation (CDF NCWAP).
- A 1999 stream survey found 43% pools by reach and 1.2 ft. depth, 23% riffles, and 29% flatwater. Substrate consisted of 47% cobble/ gravel, 30% boulders, and 12% silt and sand.
- Substantial post logging damage noted. The McKenzie Ck. sub-basin has been a high priority area with the Gualala Watershed Restoration Council. Numerousrestoration projects have been completed.
- Temperature data for two sites in McKenzie Creek were available for 2000 and 2001 for a total of four observations. MWATs ranged from 61-68 F (16-20 C), and seasonal maxima from 61-75 F (16-24 C). Both sites had higher seasonal maxima in 2001, from 61F to 75F and from 70F to 75F. The MWAT at one site, mck617, increased from 61F to 66F in 2001, and at the other, mck615, decreased from 68F to 66F. (WQ NCWAP)

Wild Hog Canyon Creek and Carson Creek

- Both creeks were logged during the late 1950s. The haul road and landing sites lined the main channel. Overstory riparian canopy was removed. In Wild Hog Canyon, a 1999 stream survey found 15% pools at medium depth 0.6 ft., 43% flatwater, and 32% dry units. Substrate consisted of 38% cobble/ gravel, 38% boulders, and 15% sand and silt. In Carson Ck. to the south, a 1999 survey found 43% pools at 1.1 ft. mean depth. Cobble gravel consisted of 58% total substrate, silt and sand at 17% and bedrock at 22%. (DFG NCWAP)

Camper Creek

- The 1999 survey found 43% pools at median 1.2 ft. depth. Cobble/ gravel consisted of 50% substrate, 21% bedrock, and 28% sand and silt. (DFG NCWAP)

UPPER AND LOWER PEPPERWOOD CREEKS.

Logged during the early 1960s. Main haul roads followed the stream channel among numerous instream landings (see Logging Impacts Map)(CDF NCWAP). .

Lower channel of Big Pepperwood Ck. aggraded by the late 1970s, diffused across the flood plain, lost channel identity. Little Pepperwood has less gravel substrate.

Large active slide on Robinson ridge extending to Little Pepperwood Ck. (GRI 96-404, 98-318).

Steelhead 1+ decreased from 153 to 48 from 1998 to 2001at sample station PPW2 respectively (GRI, 2001).

Temperature was monitored a four sites, three in Big Pepperwood, and one in Little Pepperwood, from 1994-2000, yielding 17 observations. MWATs ranged from 58-61 F (14-16 C), all but one observation within the fully supportive range. Seasonal maxima ranged from 58-64 F (15-18 C), all below the lethal level. No spatial nor temporal trends were obvious. (WQ NCWAP)

LOWER MAINSTEM GUALALA RIVER

Temperature data for the lower mainstem are available from one site downstream of the North Fork/South Fork confluence for 2000 and 2001. MWATs were 72 F (22 C) for both years, above the fully supportive range. Seasonal maxima were 73 F (23 C) for both years. There was no change in water temperature from the Lower South Fork station to the Lower Mainstem station in 2001 (no 2000 data for the lower South Fork station available).